Golder Associates

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STUDY OF THE ALKALI REACTIVITY OF POTENTIAL CONCRETE AGGREGATE OF NEWFOUNDLAND - NEWFOUNDLAND MDA

FINAL REPORT
BY:

GOLDER ASSOCIATES LTD.

Work on the project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada, funded as part of the Canada/Newfoundland Mineral Development Agreement.

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Golder Associates Ltd.
CONSULTING ENGINEERS

March 30, 1989 861-5024

Energy, Mines and Resources Canada
CANMET, Mineral Sciences Laboratory
555 Booth Street
Ottawa, ONT
K1A 0G1

Attention: Dr. J.A. Soles

RE:REPORT ON
STUDY OF THE ALKALI REACTIVITY OF POTENTIAL
CONCRETE AGGREGATE OF NEWFOUNDLAND -
NEWFOUNDLAND MDA

Dear Sir:

One original and ten copies of the final report on the captioned project are submitted herewith.

This report completely documents the activities and findings of the field, laboratory and office phases of this project.

We wish to acknowledge the input and assistance throughout the project provided by you and to record our appreciation. Should clarification or discussion of any aspect of this submission be required please do not hesitate to contact our office.

Yours very truly,

GOLDER ASSOCIATES LTD.

Wm. L. White

Wm. L. White, P.Eng.

WLW/eo

Encl.

(D: A.S)

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TABLE OF CONTENTS

PAGE NO.

Letter of Transmittal

1.0 EXECUTIVE SUMMARY 1

RESUME DES OPERATIONS 5

2.0 INTRODUCTION 9

2.1 Project Background 9
2.2 Study Objectives 10
2.3 Project Organization and Scope 10

3.0 CONCRETE STRUCTURE EVALUATION 12

3.1 General 12
3.2 Questionnaire 12
3.3 Structure Examination 13
3.4 Core Sampling and Petrography 13
3.5 Summary and Discussion 14

4.0 GEOLOGICAL BACKGROUND 16

4.1 Southeastern Region 16

4.1.1 Regional Geology 16
4.1.2 Local Geology of Swift Current/ Adams Head Area 18
4.1.3 Morphology Swift Current Area Deposits 20
4.1.4 Geology of Current Concrete Producer Samples 21

4.2 Geology of Central Region Samples 23
4.3 Geology of Western Region Samples 25
4.4 Geology of Labrador Region Samples 26

5.0 AGGREGATE SAMPLING AND PHYSICAL TESTING PROGRAM 27

5.1 Overview 27
5.2 Aggregate Sample Procurement 27
5.3 Routine Physical Properties 29
5.4 Chemical Stability 29
5.5 Petrographic Examination 32

TABLE OF CONTENTS (CONT'D)

PAGE NO.

5.5.1 Particle Count Method 32
5.5.2 Thin Section Analysis 32
5.5.3 Constituent Terminology 33

5.6 Criteria for Sample Categorization 34
5.7 Data Presentation 35

5.7.1 Aggregate Summary Sheets 36
5.7.2 Graphical Categorization Summary 37
5.7.3 Particle Count Tables 37
5.7.4 Thin Section Analysis 38

5.8 Test Results and Discussion - Phase I Program 38

6.0 SPECIMEN EXPANSION TESTING PROGRAM 41

6.1 Overview 41
6.2 Criteria for Mortar Bar versus Concrete Prism testing 41
6.3 Materials 43

6.3.1 General 42
6.3.2 Aggregate 43
6.3.3 Cement 43
6.3.4 Water 44

6.4 Equipment 44

6.4.1 General 44
6.4.2 Moulds and Tamping Rod 44
6.4.3 Mixers, Oven and Scales 45
6.4.4 Specimen Containers 45
6.4.5 Length Comparators 46
6.4.6 Moist Curing Room 46
6.4.7 High Temperature Room 47

6.5 Casting of Specimens 47

6.5.1 Specimen Identification 47
6.5.2 Mix Design and Casting - Prisms 47

6.5.2.1 Batching 48
6.5.2.2 Mixing 48
6.5.2.3 Casting of Specimens 49
6.5.2.4 Cleaning Equipment 49

TABLE OF CONTENTS (CONT'D)

PAGE NO.

6.5.3 Mix Design and Casting - Mortar Bars 50

6.5.3.1 Batching 50
6.5.3.2 Mixing 50
6.5.3.3 Casting of Specimens 50
6.5.3.4 Cleaning Equipment 51

6.6 Specimen Storage 51
6.7 Length Measurement 51

6.7.1 Prism Measurements 51
6.7.2 Mortar Bar Measurements 52

6.8 Calculations and Plotting 52
6.9 Data Presentation 53

6.9.1 Spread Sheet 53
6.9.2 Expansion Graphs 53

6.10 Test Results and Discussion - Phase II Program 53

7.0 STUDY CONCLUSIONS 55

8.0 RECOMMENDATIONS 58

9.0 REFERENCES 60

Following Page

LIST OF TABLES

Table I - Aggregate Sample Locations & Sources 29
Table II - Chemical Analysis of Cement 43
Table C1 - Petrographic Examination Index App. C
Table D1 - Mortar Bar/Concrete Prism Index App. D

LIST OF FIGURES

Figure 1 - Sample Location and Regional Boundaries-NF 13
Figure 2 - Sample Location Plan - Swift Current Area 13
Figure 3 - Sample Location Plan - Labrador 13
Figure 4 - Generalized Regional Geology Map - NF 17
Figure 5 - Geology of Swift Current Area 18
Figure 6 - Generalized Regional Geology Map - Labrador 26

APPENDICES

Appendix 'A'	-	CONCRETE EXAMINATION REPORT Investigation of the cause of cracking of concrete in the Trinity Bay Region of Newfoundland - P.E. Grattan - Bellew, NRC.
Appendix 'B'	-	AGGREGATE TEST RESULTS Aggregate Summary Sheets and Categorization Charts Chemical Stability Test Results
Appendix 'C'	-	PETROGRAPHIC EXAMINATION DATA C.1 Particle Count Sheets C.2 Thin Section Analysis
Appendix 'D'	-	EXPANSION TEST DATA D.1 Spread Sheets D.2 Expansion Graphs

1.0 EXECUTIVE SUMMARY

This study provides an overview of the potential for alkali aggregate reactions in Portland cement concrete made with selected aggregates and rock types in the province of Newfoundland & Labrador. The rock types studied are representative of those presently being used for ready mix concrete production, and of potential aggregate sources near the head of Placentia Bay - an area being considered for the construction of a concrete offshore oil production platform. This study is, however, not comprehensive with respect to the major rock types within this province.

The study comprised the following components:

i. An owner contact survey to determine historical alkali aggregate reaction problems.

ii. Visual assessment of the performance of concrete in about 30 highway structures in the southeast corner of the province.

iii. Core sampling and petrographic examination of the concrete in eight bridges near the head of Placentia Bay.

iv. A brief review of the general geology of the province and of the locallized geology at sample locations.

v. Standard laboratory tests on 35 selected rock and aggregate samples from across the province to determine their physical and durability properties in concrete. Petrographic examinations were conducted to determine the mineralogical composition of each rock type.

vi. Standard laboratory tests were conducted on 25 mortar and 21 concrete specimens fabricated from the aggregate samples to determine the potential expansion characteristics due to alkali reaction with Portland cement. Similar tests were carried out with four control samples.

vii. Correlation, where possible, of rock types with their apparent potential for alkali reaction when such rocks are used as aggregates in concrete.

Golder Associates Ltd. managed this project, visually assessed the concrete structures, and conducted the laboratory tests on the aggregate and expansion samples. Dr. P.E. Grattan-Bellew examined a number of the structures and conducted petrographic examinations of the recovered concrete samples. Thin section petrography of selected rock types was carried out by Dr. F. Mengel. The majority of the rock and aggregate samples were collected by personnel of the Newfoundland and Labrador Department of Mines.

No documentated records or specific cases of alkali aggregate reactivity have been previously identified in this province. This is believed partially due to limited awareness of the phenomena, other more obvious causes of concrete deterioration, and probably few strongly reactive rock types.

Limited evidence of alkali reactivity was observed in most of the bridge structures examined. A moderate to strong degree of reactivity was, however, detected in the concrete from several bridges in the head of Placentia Bay - Clarenville area.

The routine laboratory tests confirmed that the aggregates and rock samples tested meet normal durability requirements. The petrographic examinations confirmed that the aggregate samples represent a wide variety of rock types and typically contain more than six constituents. Evidence of microcrystalline and strained quartz was detected in a number of samples, but generally in small to moderate amounts.

The laboratory expansion tests indicate that most of the samples exhibit slight to moderate potential for expansion in Portland cement concrete. About one quarter of the samples showed very low expansion. All the expansions recorded were less than the maximum limits currently recommended in Canada. No highly reactive rock types were tested. The laboratory tests on the control samples yielded generally anticipated results.

This study has partially met the objectives defined. However, budget limitations severely restricted the amount of data which was obtained, and the extent to which the overall objectives were met. The samples made available and tested had wide distribution across the province, but many geological areas and rock types were not assessed. With the limited data available a general overview of the potential for alkali-aggregate reactivity in selected rock types has been realized. A meaningful contribution has been made to the data base of rock and aggregate properties related to construction applications. However, insufficient data was acquired to enable correlation of rock types or geological formations with potential reactivity.

On the basis of the information obtained in this study the following specific conclusions are made:

i) Aggregates presently being used by the ready mix concrete producers sampled have low to moderate potential for alkali aggregate reactivity.

ii) Evidence of moderate to strong alkali aggregate reaction has been observed in concrete samples from several structures in the head of Placentia Bay - Clarenville area, the only location from which such samples were evaluated. On the basis of data available from this source, a limited correlation may exist between some rocks from the Love Cove and Connecting Point Groups in this area and the degree of reactivity observed. Conclusive evidence is not available with the limited data acquired by this study.

iii) Sampling for potential aggregates in the head of Placentia Bay area was restricted to shoreline locations. Samples from the major granular outwash deposits exhibit slight to moderate potential for reactivity. Test results from the three bedrock samples provided from this location do not enable conclusions or correlations regarding potential reactivity of these rock types to be made. More comprehensive sampling and testing is required to adequately assess potential bedrock sources in this area.

iv) The complex geology of this province makes correlation of rock types and alkali reactivity difficult. To meet this overall objective a systematic and comprehensive geological bedrock sampling and testing program must be co-ordinated with broad based sampling and petrographic examination of concrete from structures.

1.0 RESUME DES OPERATIONS

La présente étude est une revue du potentiel de réaction alcaline d'un ensemble de roches et d'agrégats sélectionnés dans la Province de Terre-Neuve et du Labrador, lorsqu'ils sont utilisés dans du béton au ciment Portland. Les roches étudiées sont représentatives de celles que l'on utilise à l'heure actuelle pour le béton prémélangé et aussi des sources potentielles d'agrégats au voisinage de la pointe de la Baie de Placentia - site éventuel de construction d'une plate-forme en béton pour la production pétrolière en mer. Cette étude n'est cependant pas exhaustive des principaux types de roches de la province.

L'étude comprend les composantes suivantes:

i. Une enquète auprès des propriétaires pour déterminer les problèmes de réaction alcaline au cours des années passées.

ii. Une vérification visuelle du comportement du béton sur environ 30 structures routières dans la région sud-est de la province.

iii. La prise d'échantillons et l'examen pétrographique du béton en provenance de 8 ponts, près de la pointe de la Baie de Placentia.

iv. Une brève revue de la géologie générale de la province et de la géologie propre aux sites d'échantillonnage.

v. Des essais standard de laboratoire sur 35 échantillons de roche et d'agrégats en provenance de la province pour déterminer leur propriétés physiques et leur durabilité dans le béton. Des examens pétrographiques ont été effectués pour établir la composition minéralogique de chaque type de roche.

vi. Des essais standard de laboratoire sur 25 éprouvettes de mortier et 21 de béton fabriquées à partir des échantillons d'agrégats, pour établir les caractéristiques éventuelles d'expansion due à la réction alcaline avec le ciment Portland. Des essais semblables ont été effectués sur 4 échantillons de référence.

vii. L'établissement d'une corrélation, si possible, entre le type de roche et le potentiel apparent de réaction alcaline lors de l'utilisation de ces roches comme agrégats pour le béton.

Golder Associates Ltd a géré le projet, procédé aux examens visuels des stuctures en béton et mené les essais de laboratoire sur les échantillons d'agrégats ainsi que les essais d'expansion. Dr. P.E. Grattan-Bellew a inspecté plusieurs des structures et effectué les examens pétrographiques des échantillons de béton prélevés. La pétrographie par lames minces des types de roches sélectionnées a été réalisée par Dr. F. Mengel. La majorité des échantillons de roche et d'agrégats a été récoltée par le personnel du Département des Mines de Terre-Neuve et du Labrador.

On n'a pu relever aucun rapport documenté ou cas précis de réaction alcaline d'agrégat dans la province. Ceci est sans doute dû au manque de conscience du problème, à des causes plus évidentes de détérioration et probablement à la rareté des roches hautement réactives.

Des signes limités de réaction alcaline ont été observés sur la plupart des ponts examinés. Cependant un degré modéré à fort de réaction a été détecté dans le béton prélevé sur plusieurs ponts dans la région de la pointe de la Baie de Placentia-Clarenville.

Les essais de laboratoire classiques ont confirmé que les échantillons d'agrégat et de roche remplissaient les conditions normales de durabilité. Les examens pétrographiques ont révélé que les échantillons d'agrégats représentaient une large variété de roches et contenaient généralement plus de 6 constituants.

Plusieurs échantillons ont indiqué la présence de quartz sous forme microcristalline déformée, mais en quantités faibles à modérées généralement.

Les essais d'expansion en laboratoire indiquent que la plupart des échantillons montrent un potentiel d'expansion léger à modéré dans le béton au ciment Portland. Environ un quart des spécimens ont montré une expansion très faible. Toutes les mesures d'expansion ont été inférieures aux limites présentement recommandées au Canada. Lors des essais, il n'y a eu aucun type de roche hautement réactif. Les essais de laboratoire sur les échantillons de référence ont fourni, en général, les résultats attendus.

La présente étude a partiellement rempli les objectifs définis. Cependant les limites budgétaires ont sévèrement limité le nombre de données obtenues et la généralité des objectifs atteints. Les échantillons disponibles et soumis aux essais étaient largement répartis dans la province mais beaucoup de régions géologiques et de types de roche n'étaient pas représentés. Avec ces données limitées on a réalisé une revue génerale du potentiel de réaction alcaline sur un ensemble de types de roches. Ceci constitue une contribution significative à la banque de données sur les propriétés des roches et agrégats utilisés dans la construction. Cependant la quantité de données n'a pas été suffisante pour permettre d'établir une corrélation entre types de roche ou formation géologique et ráctivité alcaline.

Sur la base de l'information obtenue lors de la présente étude, on peut tirer les conclusions particulières suivantes:

i. Les agrégats actuellement utilisés pour la production de béton prémélangé et qui ont été testés ont un potentiel faible à modéré vis-à-vis de la réaction alcaline des agrégats.

ii. Une réactivité modérée à forte a été mise en évidence sur des échantillons de béton en provenance de plusieurs structures dans la région de la pointe de la Baie de Placentia-Clarenville, seule zone où de tels échantillons ont été évalués. A partir des données acquises de cette source, il peut exister une corrélation limitée entre certaines roches des groupes de Love Cove et Connecting Point dans cette région et le degré de réactivité observé. On ne peut cependant tirer de conclusions définitives à partir du peu de données obtenues.

iii. L'échantillonnage d'agrégats potentiels dans la région de la pointe de la Baie de Placentia a été limité à des sites littoraux. Les échantillons en provenance des principaux dépôts de matériaux granulaires rapportés par la mer indiquent une réactivité faible à modérée. Les résultats d'essais effectués sur les trois échantillons de roc en place dans cette zone ne permettent pas de conclusions ou de corrélations vis-à-vis de la réactivité. Un échantillonnage plus détaillé et des essais plus poussés sont nécessaires pour évaluer correctement les sources d'emprunt de roches en place dans cette région.

iv. La géologie complexe de la province rend difficile la corrélation entre type de roche et réactivité alcaline. Pour atteindre cet objectif général il faut coordonner un programme systématique et complet d'échantillonnage géologique et d'essai sur le roc en place avec des prélèvements de béton de structure sur une large base géographique et leur examen pétrographique.

2.0 INTRODUCTION

2.1 Project Background

Incidents of alkali aggregate reaction (AAR) in Portland cement concrete have been documented on a number of occasions in New Brunswick and Nova Scotia. No documented cases are known within the province of Newfoundland and Labrador. However, in view of the wide variation in geology and the range of rock types throughout this province, the potential does exist for such reactions.

Golder Associates Ltd. has been retained by Supply and Services Canada, on behalf of CANMET (EMR) to carry out an investigation of some presently-used and prospective aggregates to determine their potential long term stability with respect to alkali reactivity in concrete. Golder Associates has been the prime consultant on this project, with specialist input provided by Dr. P.E. Grattan-Bellew of the National Research Council of Canada. Dr. J.A. Soles of CANMET has severed as Scientific Authority on this project. Support was provided by the Newfoundland and Labrador Department of Mines who selected and procured samples of aggregates to be included in the testing program. This project is funded under the Canada/Newfoundland Mineral Development Agreement.

Similar but more comprehensive programs, sponsored by CANMET, are presently being conducted in New Brunswick and Nova Scotia to further assess the potential for alkali reaction in aggregates in these provinces.

2.2 Study Objectives

The purpose of this study is to provide a preliminary assessment of the degree to which rock types in this province are subject to adverse reactions with cement alkalis when used as aggregates in Portland cement concrete. More specifically, an overview is to be obtained of the potential for reaction of aggregates currently used by ready mix concrete producers and, in addition, data is to be obtained on potential aggregate sources which may be considered for use in future offshore structures for hydrocarbon development.

The broader objective of this project is to determine the potential reactivity of various rock types and units throughout the province which may be used to produce concrete. Additional information beyond the scope of this study is required to realize this objective.

2.3 Project Organization and Scope

The activities of this project are grouped broadly within three principal components as follows:

- concrete evaluation - comprising a survey questionnaire; field inspection of existing concrete structures; identification of those exhibiting potential AAR, extraction of cores from selected structures and petrographic examination of the concrete.
- laboratory test program - comprising an initial phase of routine laboratory tests to assess the physical properties and durability of representative aggregates, and a second phase of specialized testing to evaluate the potential volume change of standard mortar bar and concrete prism specimens made with the aggregates.
- correlation of the field performance of concrete structures and the results of the laboratory expansion test results with geological units and rock types to identify those units which have the potential for unacceptable levels of alkali reaction.

The level of effort and scope of this study with respect to the objectives has been restricted by the available funding for the project. In general, both the number of structures sampled (8) and the number of samples tested (35) were limited. Meaningful correlation of the potential for alkali reaction with rock type may thus only be possible for one locallized area of the province where sample density was higher. The restrictions which have occurred are noted in various sections of the document where appropriate.

3.0 CONCRETE STRUCTURE EVALUATION

3.1 General

A preliminary assessment of the extent of alkali reactivity as a factor in concrete durability in this province comprised a survey questionnaire and several reconnaissance inspection trips to examine highway structures in the southeastern corner of the province.

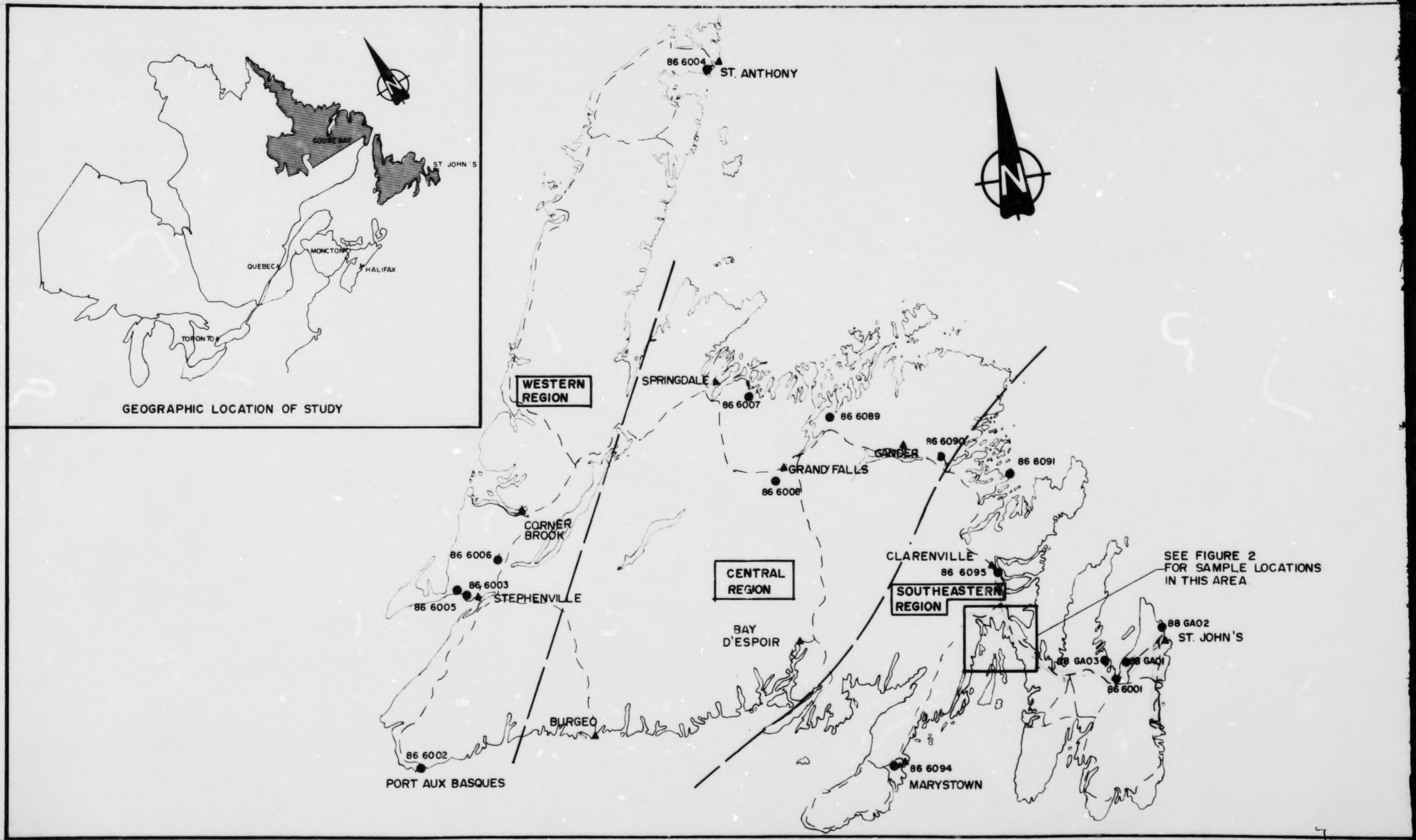
A literature search had revealed no documented evidence of alkali-aggregate reaction on record.

3.2 Survey Questionnaire

A questionnaire was prepared to determine known incidents of alkali-aggregate reaction. This questionnaire had the following distribution, with a 70 percent response:

NF Department of Transportation
Cities of St. John's and Corner Brook
NF Hydro
NF Light & Power Co. Ltd.
NF Department of Public Works & Services
NF Department of Municipal Affairs
Public Works Canada
Transport Canada - Air
Ports Canada
Coast Guard Canada
North Star Cement Ltd.
Major Contractors
Major Consulting Engineering Firms
Major Resource Industries

Responses to the questionnaire identified a range of concrete durability problems but no specific instances of alkali-aggregate reaction. In a number of cases it is suspected that respondents were not familiar with this particular deterioration phenomena.


GOOSE BAY
ST JOHN'S
QUEBEC
MONCTON
HALIFAX
TORONTO
GEOGRAPHIC LOCATION OF STUDY
N
86 6004
ST. ANTHONY
WESTERN REGION
SPRINGDALE
86 6007
86 6089
86 6090
GANDER
86 6091
GRAND FALLS
86 6008
CORNER BROOK
86 6006
86 6003
86 6005
STEPHENVILLE
CENTRAL REGION
CLARENVILLE
86 6095
SOUTHEASTERN REGION
SEE FIGURE 2
FOR SAMPLE LOCATIONS
IN THIS AREA
88 GA02
ST. JOHN'S
88 GA03
88 GA01
86 6001
BAY D'ESPOIR
BURGEO
86 6002
PORT AUX BASQUES
86 6094
MARYSTOWN

SAMPLE LOCATION AND REGIONAL BOUNDARIES
ISLAND OF NEWFOUNDLAND

1

SYMBOLS

●	AGGREGATE SAMPLE LOCATION
▲	MAJOR TOWNS & CITES
- - -	MAIN HIGHWAYS
— —	REGIONAL BOUNDARY
— — -	STRUCTURE RECONNAISSANCE ROUTE

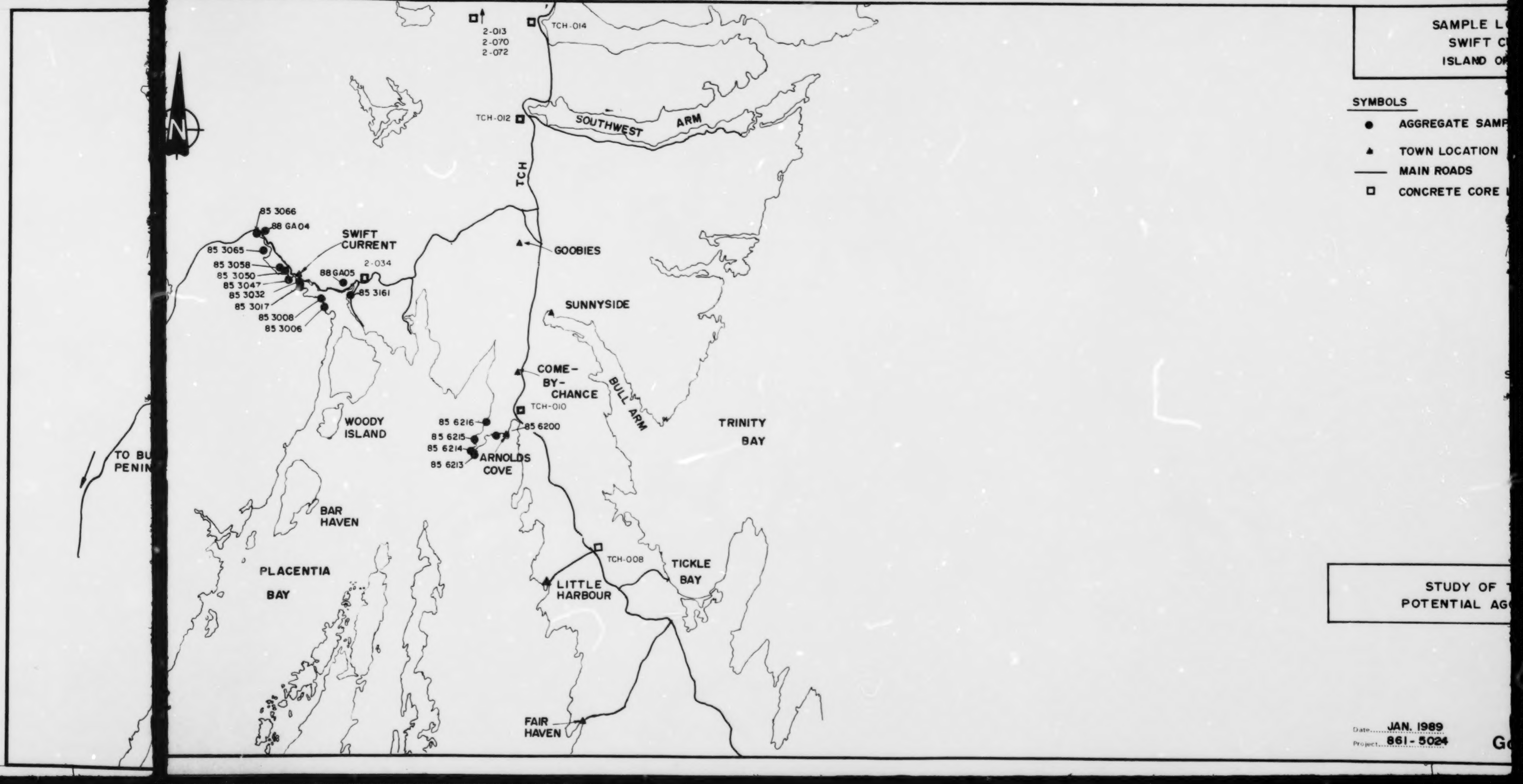
SCALE 1:2,000,000

STUDY OF THE ALKALI REACTIVITY OF
POTENTIAL AGGREGATES OF NEWFOUNDLAND

JAN. 1989
861-5024

Golder Associates

J.M.C.


SAMPLE L
SWIFT C
ISLAND O
SYMBOLS
● AGGREGATE SAMP
▲ TOWN LOCATION
MAIN ROADS
□ CONCRETE CORE
N
2-013
2-070
2-072
TCH-014
TCH-012
SOUTHWEST ARM
TCH
85 3066
88 GA04
SWIFT CURRENT
85 3065
85 3058
85 3050
85 3047
85 3032
85 3017
85 3008
85 3006
88 GA05
2-034
85 3161
GOOBIES
SUNNYSIDE
COME-BY-CHANCE
BULL ARM
TCH-010
85 6216
85 6215
85 6214
85 6213
85 6200
ARNOLDS COVE
WOODY ISLAND
TRINITY BAY
TO BU
PENIN
BAR HAVEN
PLACENTIA BAY
TCH-008
TICKLE BAY
LITTLE HARBOUR
FAIR HAVEN
STUDY OF T
POTENTIAL AG

Date JAN. 1989
Project 861-5024
G

SAMPLE LOCATION PLAN
SWIFT CURRENT AREA
ISLAND OF NEWFOUNDLAND

FIGURE **2**

SYMBOLS

●	AGGREGATE SAMPLE LOCATION
▲	TOWN LOCATION
——	MAIN ROADS
☐	CONCRETE CORE LOCATIONS

SCALE 1 : 250, 000

STUDY OF THE ALKALI REACTIVITY OF
POTENTIAL AGGREGATES OF NEWFOUNDLAND

Date JAN. 1989
Project 861 - 5024

Golder Associates

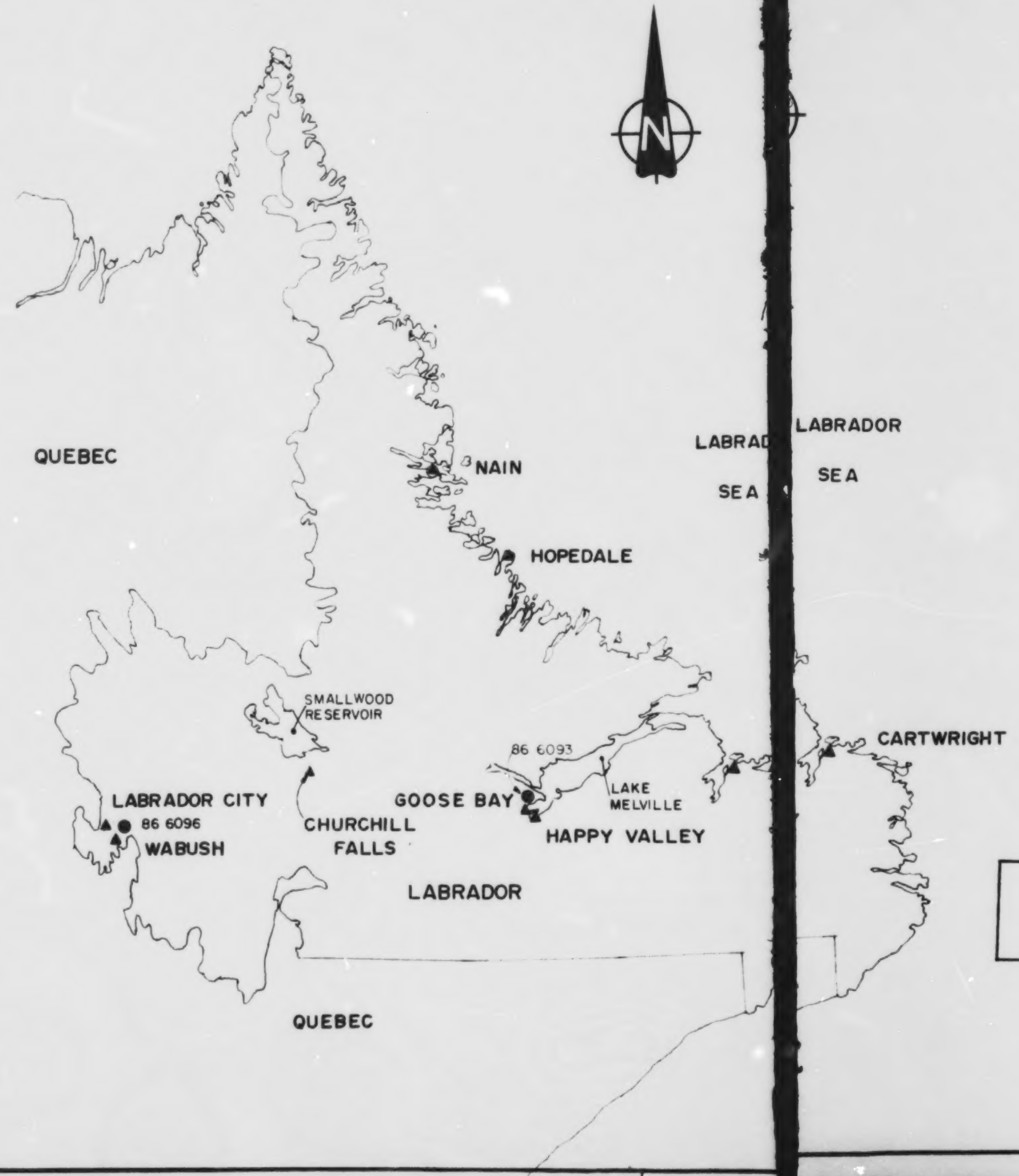
Drawn J.M.C.
Chkd

SAMPLE LOCATION PLAN
LABRADOR

FIGURE 3

SYMBOLS

- ● SAMPLE LOCATION
- ▲ MAJOR TOWNS


N
QUEBEC
NAIN
HOPEDALE
LABRADOR SEA
SMALLWOOD RESERVOIR
86 6093
CARTWRIGHT
LAKE MELVILLE
GOOSE BAY
HAPPY VALLEY
LABRADOR CITY
86 6096
WABUSH
CHURCHILL FALLS
LABRADOR
QUEBEC

SCALE 1 : 4,820,000 (Approx.)

STUDY OF THE ALKALI REACTIVITY OF
POTENTIAL AGGREGATES OF NEWFOUNDLAND

Date JAN. 1989
Project 861-5024

Golder Associates

Drawn J.M.C.
Chkd

3.3 Structure Examination

Approximately 30 bridge structures were inspected during several reconnaissance trips to assess general concrete performance, and to determine if surficial indications of alkali-aggregate reaction were present.

The strucutres which were thus examined were limited to the St. John's area and along several sections of highway mainly within the Avalon Peninsula. These areas are indicated on Figure 1. It is apparent that bridge structures in a relatively small area of the province have been examined to date.

The reconnaissance inspections revealed many concrete bridge structures which have undergone various forms and degrees of concrete deterioration. Several of the structures exhibited surface map cracking. Most of these structures are at least 15 years old. Unfortunately, a common maintenance practice in this province is to apply a wash or light parge to the more visible portions of structures which show surface deterioration, and thus the original surfaces of many older structures cannot be directly observed.

3.4 Core Sampling and Petrography

On the basis of the reconnaissance inspections, eight bridge structures in the head of Placentia Bay - Clarenville area were selected for core sampling (See Figure 2). Cores were extracted in accordance with Test Method A 23.2-14-C of CAN3-A23.2-M77, primarily from the end blocks and walkways. The cores were subsampled with one section of each subsequently examined microscopically by the specialist consultant for this study; Dr. P.E. Grattan-Bellew.

The petrographic examination of the core samples recovered from the eight bridge structures reveals evidence of strong potential alkali aggregate reaction in three structures and moderate reaction in two others.

The findings of this detailed examination are presented in a separate report included as Appendix 'A'.

3.5 Summary and Discussion - Structure Evaluation

On the basis of responses to the survey questionnaire, it is concluded that respondents did recognize a range of concrete deterioration and durability problems. However, awareness of potential or actual cases of alkali aggregate reaction in this province is very limited. No specific cases of AAR were confirmed by this survey.

Observations made during the reconnaissance inspection of the bridge structures indicates that potential alkali aggregate reactions may have occurred in a number of the structures examined. Most of the evidence of such reactions is present in bridges near the isthmus of the Avalon Peninsula and near the Town of Clarenville. The severity of the cracking observed suggests that such potential reaction is typically strong to moderate, which was confirmed in core samples from five bridges.

In addition to the evidence of alkali aggregate reaction in the core samples from the Come-by-Chance/Clarenville area, indications of potential reaction have been noted in several samples from old structures in the St. John's area.

The information obtained to date from the structure examinations and concrete samples suggests that slight to strong alkali aggregate reactions have occurred in a number of concrete structures in the area studied. The information obtained to date, however, indicates that this phenomena is probably localized and restricted to a few geological units.

4.0 GEOLOGICAL BACKGROUND

A primary objective of this study is to relate laboratory test performance of the samples to definable geological units in the field. The purpose of this section is to outline these relevant units as clearly as possible. For ease of discussion the province is divided into four regions based on geographical and geological setting:

4.1 Southeastern Region
4.2 Central Region
4.3 Western Region
4.4 Labrador

These regions are similar to common general geological divisions of the province (Figures 1, 3, 4, and 6).

4.1 Southeastern Region

This section provides the most detailed geological information, as the majority of the samples tested (approximately 70 percent) were obtained in this region which is within the Avalon Zone of the Appalachian Orogen.

4.1.1 Regional Geology

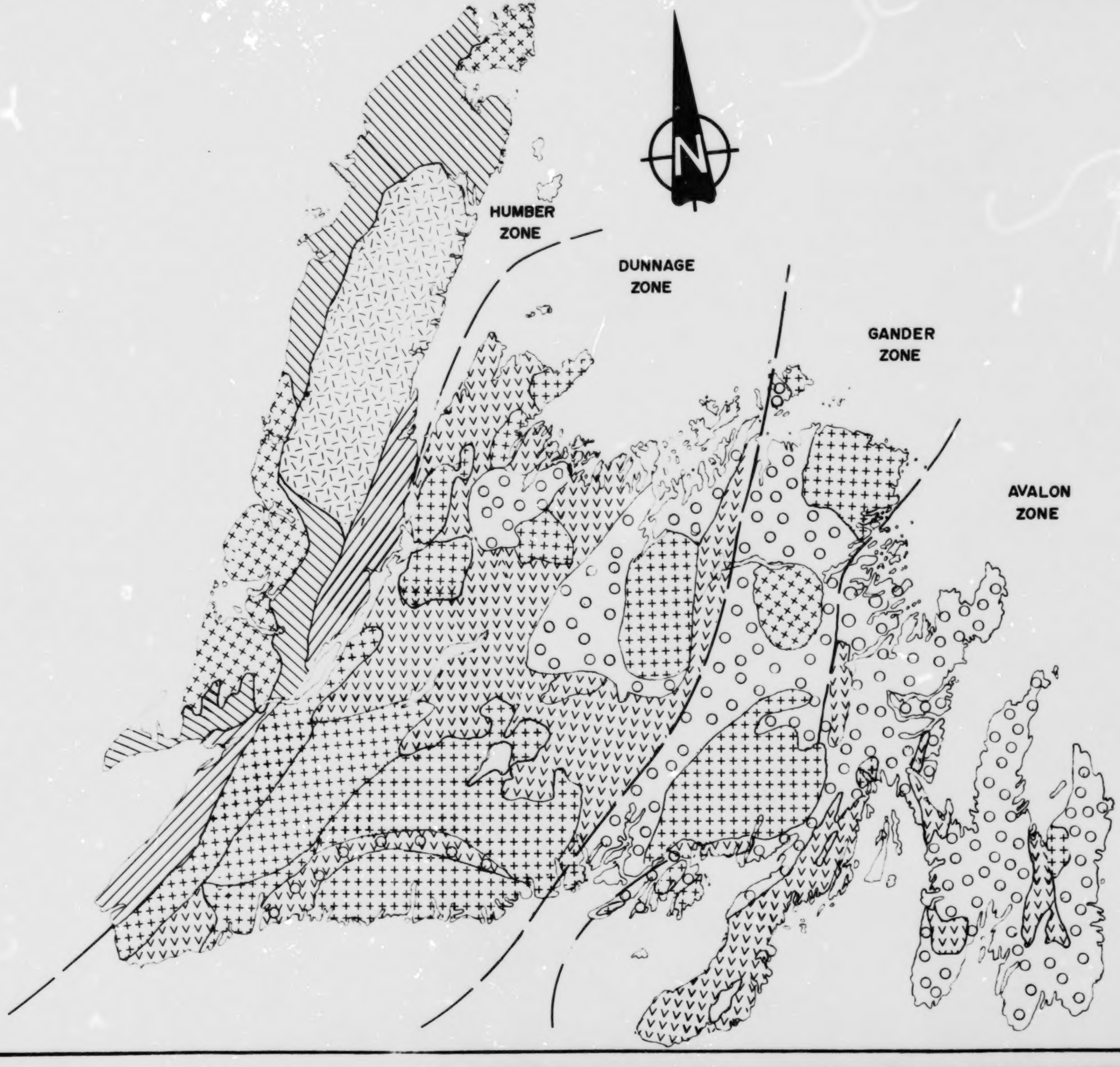
The Avalon Zone is characterized by an extensive area of late Precambrian rocks that extend discontinuously throughout eastern North America from Newfoundland to Florida. This terrane has been correlated with similar late Precambrian sequences in North America and western Europe (Williams and Hatcher 1983).

The Avalon Terrane is now believed by some to represent a structurally complex collage of smaller terranes, formed by collision during the late Precambrian Cadomian orogeny (Rast and Skekan 1983; Keppie and Smyth 1983) or during the Alleghanian Orogeny (O'Hara and Gromet 1983). This hypothesis tends to reduce the problems previously associated with stratigraphic correlations across the Avalon Zone.

The Avalonian stratigraphy in Newfoundland may be discussed in terms of three main assemblages (Figure 4), two late Precambrian and one Paleozoic (King et al. 1974). In New Brunswick, the lowermost assemblage is underlain by a Middle Proterozoic or older gneissic basement and its carbonate-clastic cover (Rast and Skehan 1983).

The lowermost assemblage consists of rhyolitic volcanic and cogenetic plutonic rocks, with closely related volcaniclastic sedimentary rocks. This assemblage consists of two main series of Proterozoic igneous rocks. The older Burin Group is a thick sequence of submarine basalts and mafic intrusions. A later sequence of subaerial volcanic rocks includes the Connaigre Bay, Long Harbour, Marystown, Love Cove and Harbour Main Groups. Granitoid plutons, including the Swift Current and Holyrood granites, typically yield ages in the 620 to 540 Ma range. These ages are generally considered to be characteristic of the 'Avalonian' orogeny. Chemical studies have shown these plutons to be of calc-alkaline affinity (O'Driscoll and Strong, 1979).

The middle assemblage is a thick sequence of clastic sedimentary rocks derived from the lower assemblage, exposed in several wide belts and a few isolated strips. These rocks include the Conception, St. John's, Rock Harbour, Musgravetown, Signal Hill and possibly the Connecting Point Groups.


N
HUMBER ZONE
DUNNAGE ZONE
GANDER ZONE
AVALON ZONE

REFERENCES:

1. GEOLOGY OF THE IS
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DEPARTMENT OF MI
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2. WILLIAMS, H., 1979
OROGEN IN CANADA:
SCI., V16, PP 792 -

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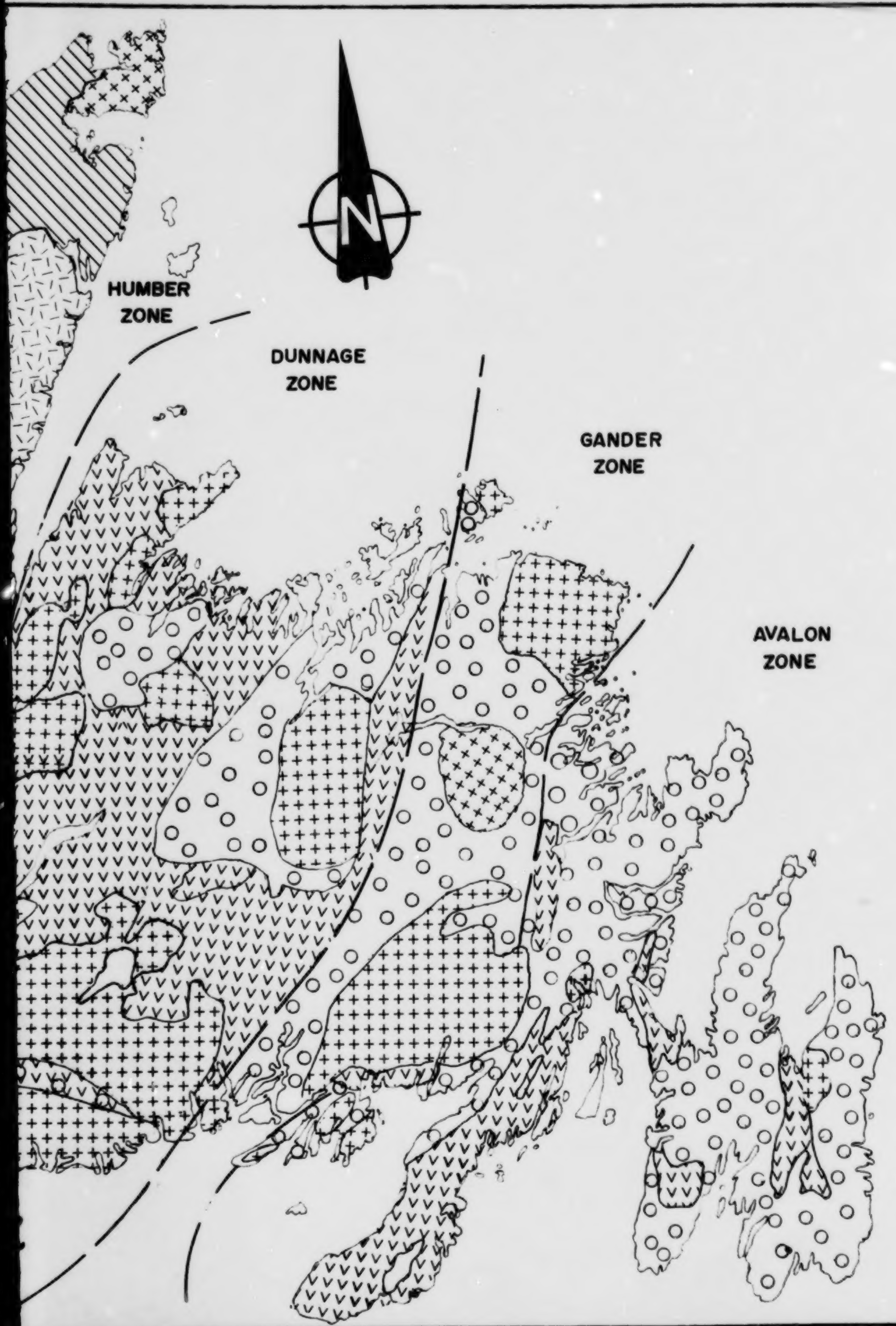
STUDY OF THE ALKAL
POTENTIAL AGGREGATES

GENERALIZED REGIONAL GEOLOGY MAP
ISLAND OF NEWFOUNDLAND

4



Avalon Zone

Carboniferous	
⊞	St. Lawrence Granite
Precambrian	
⊞	granite: primarily Holyrood and Swift Current Granites
○	clastic sedimentary rocks: (primarily Musgravetown Group and equivalents, Connecting Point and Conception Groups)
V	felsic and mafic volcanic flows and pyroclastics (primarily Marystown and Harbour Main Group, Bull Arm Formation)

Gander Zone

Devonian	
⊞	granite (primarily Ackley and Deadman's Bay Granite)
Ordovician	
○	clastic sedimentary rocks (primarily the Gander Group)

Dunnage Zone

Devonian to Silurian	
⊞	granite, includes primarily North Bay and Burgeo Batholiths, Mount Peyton, Gander Lake, Topsails, Rose Blanche Granites, Hungry Mountain Complex.
Silurian	
V	mafic and felsic volcanic rocks; includes Springdale, Wild Bight, Victoria Lake, Moreton's Harbour, Buchans and Roberts Arm Groups.
Ordovician	
○	clastic sedimentary rocks; includes Bay du Nord and Botwood Groups.

Humber Zone

Carboniferous	
▨	marine and non marine sedimentary rocks, includes Codroy, Deer Lake and Anguille Groups.
Middle Ordovician	
×	allochthonous rocks (emplaced by Middle Ordovician), includes St. Anthony Complex and Bay of Islands Complex.
Ordovician to Cambrian	
▧	carbonate sedimentary rocks, primarily St. George Group, March Point and Petit Jardin Formations.
Precambrian -	Helikian to Aphebian
⁂	gneiss

REFERENCES:

1. GEOLOGY OF THE ISLAND OF NEWFOUNDLAND: MAP 83 - 106 DEPARTMENT OF MINES AND ENERGY, NEWFOUNDLAND.

2. WILLIAMS, H., 1979. APPALACHIAN OROGEN IN CANADA. CAN. J. EARTH SCI., V16, PP 792 - 807.

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STUDY OF THE ALKALI REACTIVITY OF
POTENTIAL AGGREGATES OF NEWFOUNDLAND

JAN. 1989
861-5024

Golder Associates

J.M.C.

The uppermost assemblage comprises a sequence of earliest Cambrian orthoquartzites overlain by a Cambro-Ordovician fossiliferous mudstone-limestone-shale-sandstone sequence.

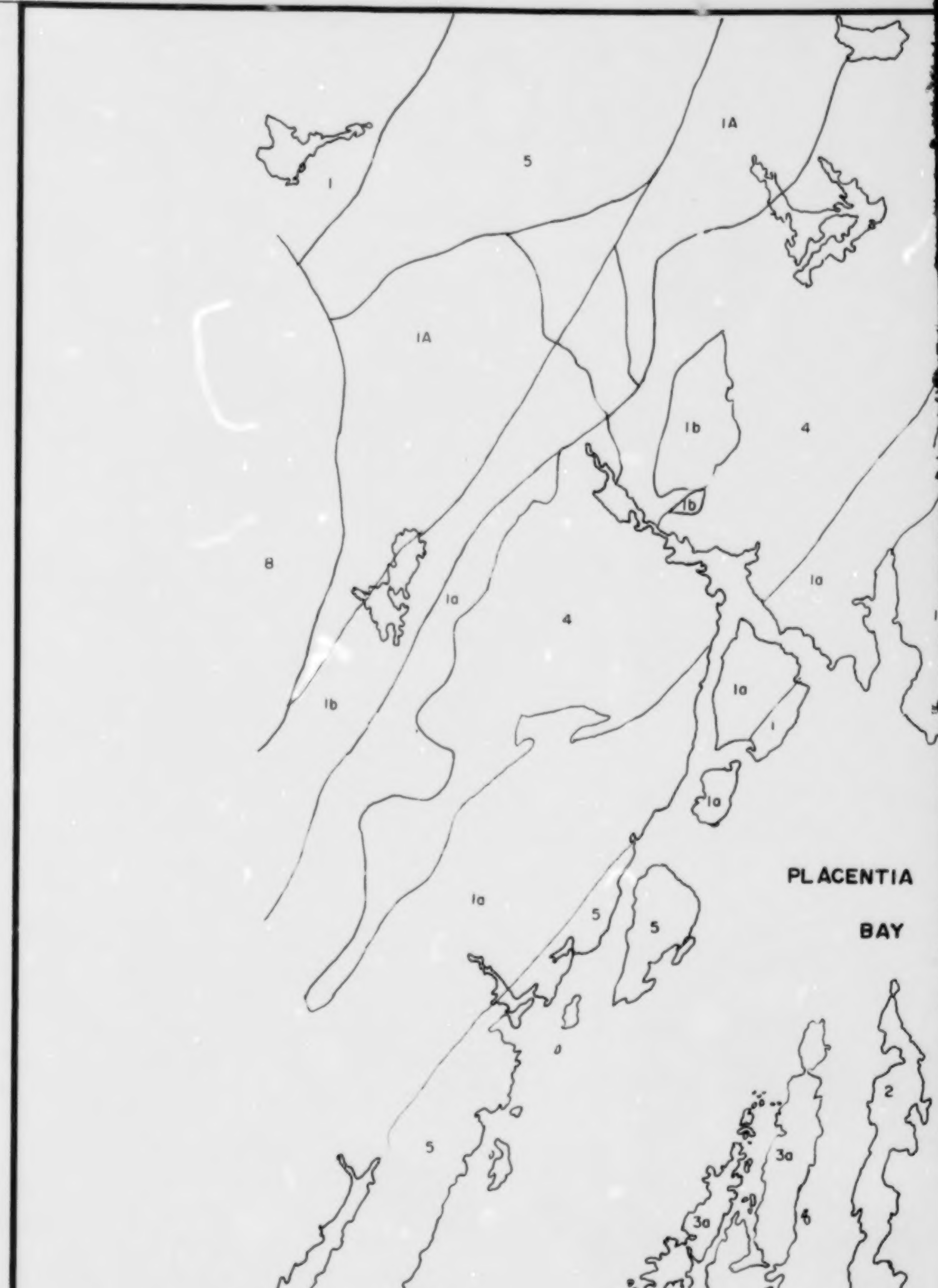
This sequence unconformably overlies older assemblages and also occurs in downfaulted patches throughout the Avalon Terrane.

4.1.2 Local Geology of Swift Current/ Adams Head Area

Samples obtained from the Swift Current area are lithologically dominated by mafic and felsic volcanic rock types, whereas Adams Head samples are comprised entirely of arkose with minor amounts of diabase. Most samples collected from Swift Current, Pipers Hole and Black River Point are sand and gravel alluvium, deposited along the shores and at the mouth of Pipers Hole River. A bedrock sample of Swift Current Granite was obtained from a roadside outcrop. The morphological description of these alluvium deposits is provided in the following Section 4.1.3.

The local geology of the Swift Current area is dominated by the Swift Current granite (Figure 5). This intrusive is of variable composition, and in the study area is described as medium grained, foliated to massive biotite hornblende granite, granodiorite, syenite and minor aplite (O'Driscoll and Hussey 1976).

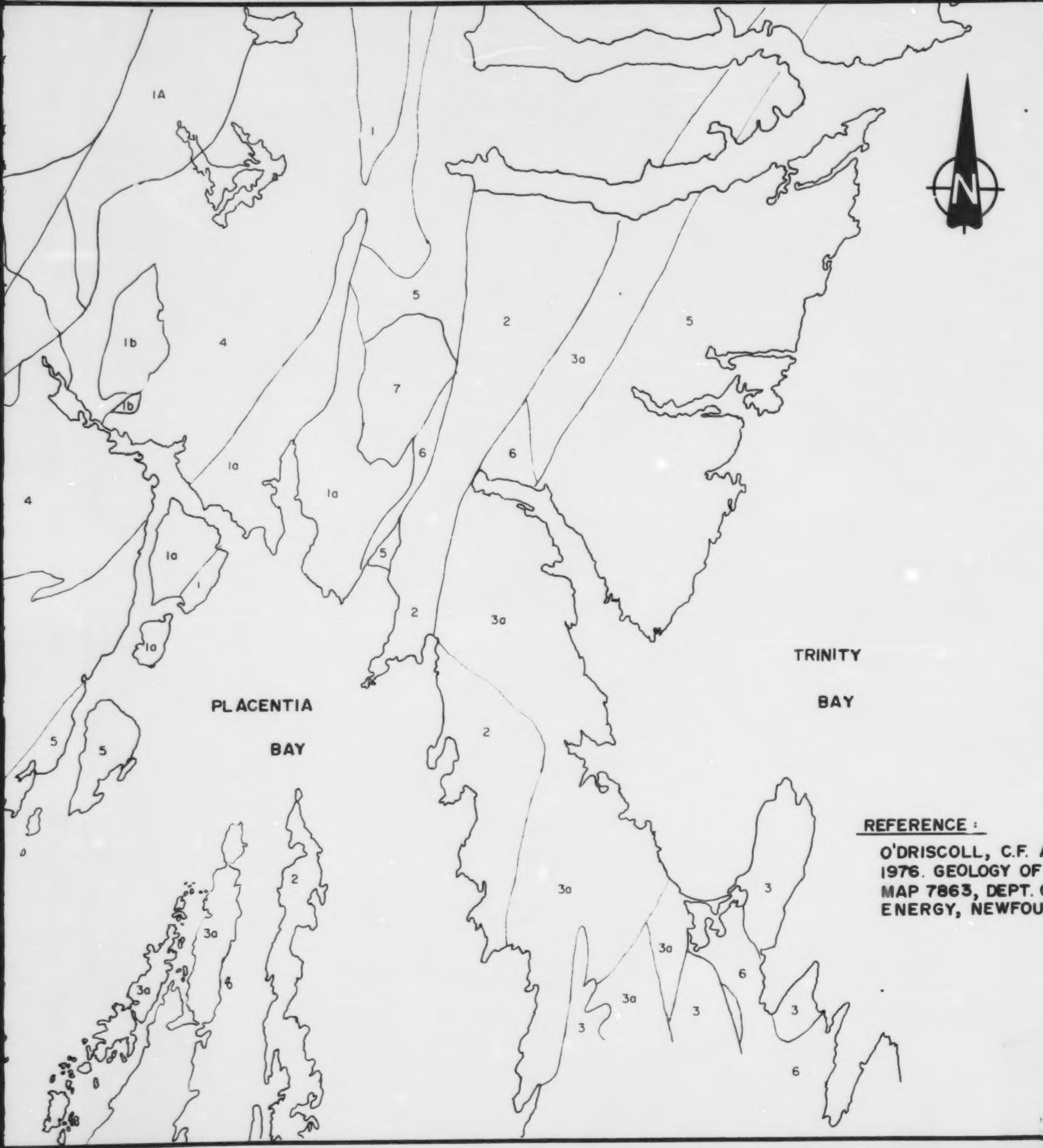
The granite is bounded both to the northwest and southeast by the Sound Island Formation of the Love Cove Group ('Lower Assemblage', Section 4.1.1). This formation is most prominent in the northwest where it occupies a narrow northeast-trending belt with an average width of approximately 2 km. It is comprised primarily of felsic and mafic flows and tuffs with minor sandstone and conglomerate.



1A
5
1
1A
8
1b
1b
1b
4
1a
4
1a
1a
1
1a
1a
PLACENTIA
BAY
5
5
1a
5
2
3a
3a
8

GEOLOGY OF SWIFT CURRENT AREA
ISLAND OF NEWFOUNDLAND

FIGURE 5



REFERENCE :

O'DRISCOLL, C.F. AND E.M. HUSSEY, 1976. GEOLOGY OF SOUND ISLAND, MAP 7863, DEPT. OF MINES AND ENERGY, NEWFOUNDLAND.

LEGEND

Devonian and Earlier

8	Ackley City Granite: massive, pink, coarse-grained, biotite granite.
7	Predominantly diorite, gabbro and diabase.

Lower Cambrian

6	Bonavista, Smith Point and Brigus Formations: red and green slate.
5	Random Formation: predominantly white quartzite.

Hadrynian or Older

4	Swift Current Granite: medium grained, massive to foliated, biotite hornblende granite.
3	Musgravetown Group: red, green and grey arkose, siltstone, conglomerate and slate.
3a	Bull Arm Formation: acidic to basic volcanic flows.
2	Connecting Point Group: green to black greywacke and cherty quartzite slate.
1	Love Cove Group: weakly metamorphosed basic to acidic volcanic rocks
1a	Sound Island Formation and equivalents. Acidic to basic volcanic flows and tuffs.
1b	Sandstone, siltstone, greywacke and conglomerate.

STUDY OF THE ALKALI REACTIVITY OF
POTENTIAL AGGREGATES OF NEWFOUNDLAND

Date JAN. 1989
Project 861-5024

Golder Associates

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Farther to the northwest, both the Love Cove and Musgravetown Groups form northeast trending belts (Figure 5). The Love Cove Group is comprised primarily of felsic and mafic volcanic rocks, whereas the Musgravetown Group is comprised primarily of clastic sedimentary rocks.

The alluvium deposits in the Swift Current area are comprised of a combination of glaciofluvial, organic and marine sediments. Both the Swift Current and Pipers Hole deposits are interpreted to be glaciofluvial, with the Pipers Hole deposit exhibiting a distinctive deltaic morphology.

The provinence of these deposits is open to geomorphological interpretation. Petrographic analysis clearly suggests a significant portion of these samples have been derived from felsic and mafic volcanics of the Love Cove Group. Pipers Hole River is clearly a major sediment-transporting feature. Several samples also contain significant amounts of granitoid lithologies apparently derived locally from the Swift Current granite.

The Adam's Head region is underlain by rocks of the Connecting Point Group. This group of Proterozoic marine sediments is typified by greenish grey slatey shale, siltstone and greywacke with minor amounts of conglomerate. It forms a narrow belt in the western Avalon zone, extending from Placentia Bay in the south to Bonavista Bay in the north. O'Driscoll and Muggridge (1979) describe the Connecting Point Group in the Placentia Bay area as comprising a lower unit of turbidites coarsening upwards into an upper unit of coarse sandstone and conglomerate.

4.1.3 Morphology of Swift Current Area Alluvium Deposits

This area is known to host several large reserves of sand and gravel which may be suitable concrete aggregate for offshore platform construction. This aggregate reserve may be easily mined and transported by barge to construction sites.

Three of these deposits were sampled by personnel of the Newfoundland Department of Mines. The following is a brief summary of the composition, morphology and estimated reserves of these deposits as outlined by Ricketts (1986):

1) **Swift Current Deposit (seven samples)**

   This deposit is located east of the Pipers Hole Deposit on the south side of Swift Current Bay, a tidal inlet. It contains coarse, medium and fine sands, gravels, sandy gravels, clays and silts. The deposit is approximately 2800 m long, 700 m wide and 4 to 11 m in height, and is disected by three small intermittant streams. The deposit is overlain by dense forest growth and 30 to 40 percent peatland. The A and B soil horizons reach depths of one metre in several locations.

2) **Pipers Hole Deposit (three samples)**

   This deposit is located on the southwest bank of Pipers Hole River. It contains 75 to 80 percent sand with some silt, the remainder is sandy gravel and gravel. It is overlain by a veneer of gravel in most areas. The deposit is currently used by the Department of Transportation for road sands during the winter months. It has been quarried for more than 15 years, and is approximately 20 percent mined out.

3) **Black River Deposit (one sample)**

   This deposit was sampled in the area east of Vicuna Island on the eastern side of the entrance to Black River Cove. This deposit is composed predominantly of sand sized material. It is approximately 300 m long, 300 m wide and has a maximum height of 11 m, which tapers off at both ends. Small deposits of compacted tills and minor gravel are located south of the sand deposit.

The above sample locations are indicated on Figure 2.

4.1.4 Geology of Current Concrete Producer Samples Southeastern Region

Samples have also been procured from current aggregate and concrete producers in the Southeastern Region. This section outlines background geology for the following seven additional locations (Figures 1, 2 and 4).

1. Sand and gravel quarry in Holyrood
2. Sand and gravel deposit in Seal Cove
3. Rock quarry in White Hills (St. John's)
4. Sand and gravel quarry in Marystown
5. Sand and gravel deposit in Mackinsons
6. Sand and gravel quarry in Clarenville
7. Sand and gravel quarry in Eastport

1) 86 6001 - Holyrood, Conception Bay

This sample was taken from a sand and gravel quarry stockpile operated by Concrete Products Limited near Holyrood. The sample is comprised primarily of granite, and is assumed to have originated from the Holyrood Plutonic Series. These plutonic rocks are interpreted to intrude rocks of both the Harbour Main and Conception Groups. The lithology is generally medium grained, pink to grey, massive granite. Regionally, monzonite, quartz diorite and gabbro from part of this plutonic series. Thin section analysis reveals that much of the quartz is generally unstrained.

2) 88 GA01 - Seal Cove, Conception Bay

Coarse and fine aggregate was obtained from a sand and gravel producer in this area. This aggregate is comprised primarily of granitic fragments which have probably been derived from the Holyrood intrusive. The volcanic fragments appear to have been derived locally from the Harbour Main Group.

3) 88 GA02 - White Hills, St. John's

This sample was procured from a crushed aggregate stockpile of Atlantic Concrete Ltd. This is one of seven known bedrock samples collected in this study. The geology of the White Hills area is comprised primarily of green to grey sandstone and minor pebble conglomerate of the Hadrynian-aged Signal Hill Group. These rocks are typically thickly bedded and massive. The Signal Hill Group is part of the 'middle assemblage' of clastic sedimentary rocks (Section 4.1.1).

4) 86 6094 - Marystown, Burin Peninsula

The aggregate sample was obtained from a sand and gravel producer near Marystown. The Marystown area is underlain predominantly by the Hadrynian-aged Marystown Group which is locally comprised of mafic to felsic volcanics, including flows and pyroclastics.

5) 88 GA03 - Mackinsons, Conception Bay

This sample was obtained from both sand and gravel deposits and bedrock. The geology of this area is dominated by the Brook Formation of the Conception Group. This lithology is primarily composed of green siliceous siltstone and sandstone with minor tuff.

7

6) 86 6095 - Clarenville, Trinity Bay

The sample was obtained from a sand and gravel supplier east of Clarenville. The sample is comprised predominantly of tuffaceous sandstone, granite and sandstone. It is believed that the majority of this sample is derived from the Hadrynian-aged Connecting Point Group which is comprised primarily of green graywacke and siliceous sandstone and slate.

7) 86 6091 - Eastport, Bonavista Bay

This aggregate is comprised primarily of granite fragments. The geology of the Eastport area is dominated by clastic sedimentary rocks of the Hadrynian-aged Connecting Point Group. It is therefore anticipated that the origin of the granitic fragments within the till is derived from the Devonian-aged granitic plutons to the west. The Maccles Lake Granite situated to the west of Eastport is the most probable source, given an ice direction towards the northeast.

4.2 Geology of Central Region Samples

This region includes rocks of the Gander and Dunnage Zones as described by Williams (1983) (Figure 4). Only ten percent of the samples provided for the study were obtained from four ready mix concrete suppliers in this region (Figure 1).

1) 86 6007 - Springdale

The aggregate obtained from this source is likely to have been derived primarily from Devonian-aged granitic rocks as part of the Topsails Intrusive Suite within the Middle Arm Ridge area. This intrusive is dominated by quartz feldspar granite porphyry.

Less dominant fractions of this source include sandstone and rhyolitic fragments which have most likely been derived from the Devonian to Silurian-aged Springdale Group.

2) 86 6008 - Grand Falls

The aggregate was obtained in this area from a sand and gravel deposit. The geology of the Grand Falls area is dominated by terrestrial mafic and felsic volcanic rocks and sedimentary rocks of the Silurian-aged Botwood Group.

3) 86 6089 - Lewisporte

The Lewisporte Area is underlained primarily by an assortment of mafic flows and volcaniclastics of the Botwood Group. South of Lewisporte, the geology is dominated by micaceous sandstone and siltstone, also part of the Botwood Group.

Granite is the primary lithology comprising the aggregate obtained from the Lewisporte area. It is anticipated that this aggregate was derived from the Mount Peyton Intrusive Suite, comprising diabase gabbro and diorite.

4) 86 6090 - Butts Pond

The Butts Pond area is underlain primarily by rocks belonging to the middle to lower Ordovician-aged Square Pond Gneiss. These rocks are comprised primarily of pelitic and semipelitic paragneiss and schist.

The granite component of this aggregate is apparently derived from the Middle Brook Granite. This intrusive is interpreted to be Devonian in age and is composed of massive megacrystic biotite granite.

4.3 Geology of Western Region Samples

This region encompasses the Humber Zone of the Appalacian Orogen (Williams, 1983) (Figure 4). The samples supplied from this region represent five widely-separated ready mix concrete production operations (Figure 1).

1) 86 6002 - Port aux Basques

Port aux Basques Gneiss is the predominant lithology in the Port aux Basques area. This intrusive is described by Brown (1977) as a coarse grained, high grade, well banded gneiss containing garnet, staurolite, kyanite and sillimanite, and is interpreted to be Precambrian in age.

2) 86 6003 - Stephenville Crossing

This sample is apparently derived from the autochthonous, Helikian-aged Indian Head Complex. These rocks are generally quartzofeldspathic gneisses, however well-defined fabrics are difficult to discern within aggregate sizes.

3) 86 6004 - St. Anthony

This sample is comprised mainly of medium grey limestone. The dominant limestone unit in this region is the Lower Ordovican- aged St. George Group. This unit is comprised of an assortment of interbedded limestone and dolomite.

4) 86 6005 - Stephenville

The sample was obtained from an aggregate supplier situated within the geographical lowland north of Stephenville. This area is situated west of the Indian Head Mountain Range and forms part of the extensive glacial deposit, north of St. George's River. Due to the complex nature of the glacial geology in this area determination of the geological origin of these fragments will require more detailed study.

5) 86 6006 - Gallants

The geology of the Gallants area is dominated by limestone of the St. Georges Group. However, the primary aggregate components suggest that the sand and gravel deposits in this area are composed of plutonic, volcanic and clastic sedimentary rocks, and are therefore likely to be derived from the Humber Arm Supergroup.

4.4 Geology of Labrador Samples

Labrador is located in the Grenvillian Province of the Canadian Shield (Figure 6). The two samples provided represent concrete aggregates from the two main population centers in this largely undeveloped region (Figure 3).

1) 86 6093 - Goose Bay

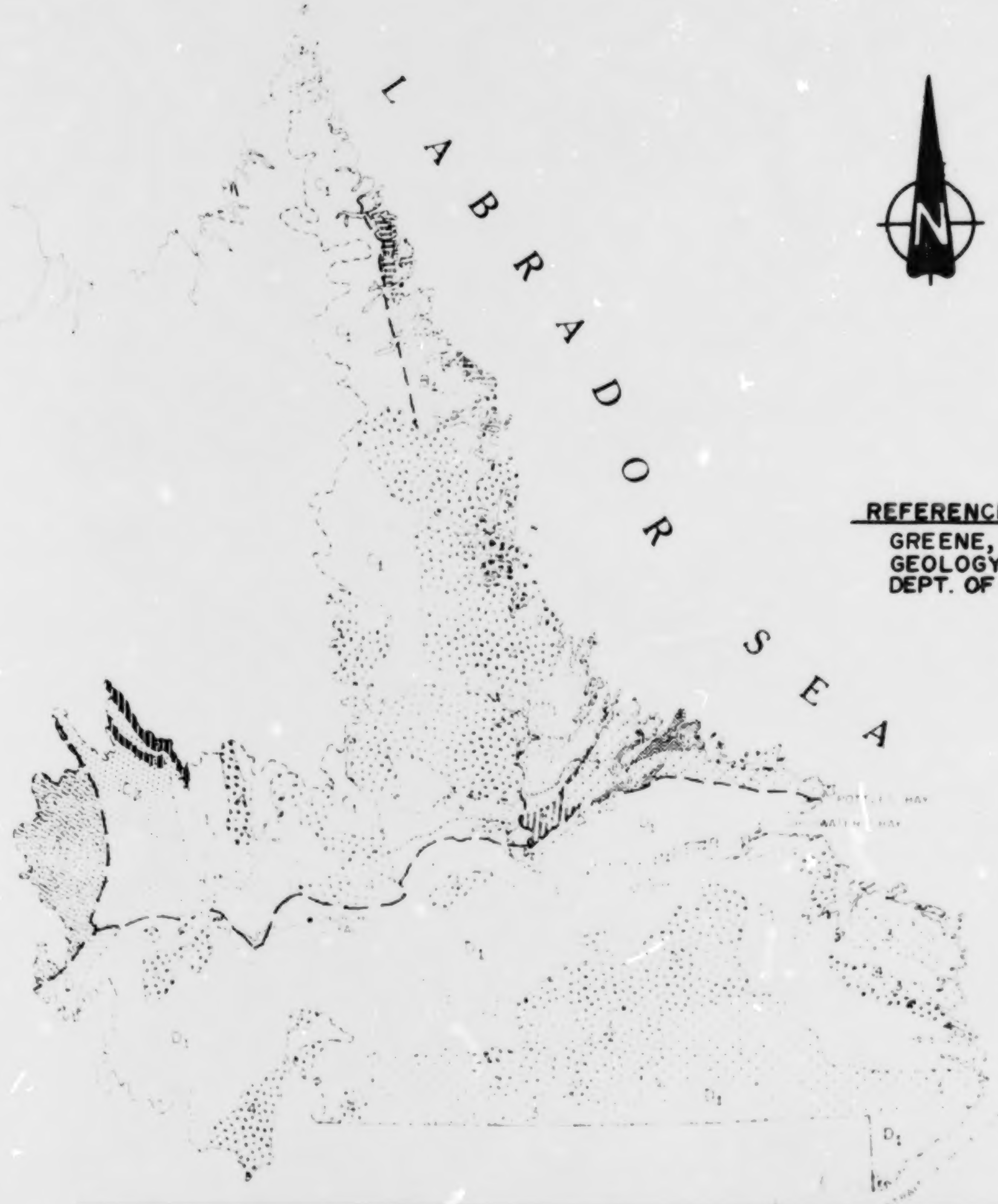
The Goose Bay area is underlain by a thick sequence of glacial outwash sands and clays. The aggregates obtained in the Goose Bay area are obtained from these deposits or from bedrock quarries. These aggregates are composed primarily of gneiss fragments and therefore are derived from the Helikian-aged quartzofeldspathic gneisses which are predominant in this region.

2) 86 6096 - Wabush

The Wabush area is underlain by Aphebian-aged metasedimentary granitoid gneisses with minor metaquartzite. This sample was obtained from metaquartzite-rich gravel deposits in this area.

GENERALIZED REGIONAL GEOLOGY MAP
LABRADOR

FIGURE 6



REFERENCE:
GREENE, B.A. 1974. AN OUTLINE OF THE GEOLOGY OF LABRADOR. INFO. CIRC. NO. 15. DEPT. OF MINES AND ENERGY, NEWFOUNDLAND.

SCALE 1 : 4,820,000 (Approx.)

LEGEND

SEDIMENTARY AND METAMORPHIC ROCKS

ST. LAWRENCE PLATFORM		
E	CAMBRIAN	Arkosic sedimentary rocks and limestone: minor basic volcanics.
GRENVILLE PROVINCE		
D3	HADRYNIAN	Supracrustal arkosic sedimentary rocks of the Double Mer Formation.
D2	HELIKIAN AND APHEBIAN	Metamorphosed equivalents of the Labrador Trough rocks, and of the Seal and Croteau Groups.
D1	HELIKIAN AND EARLIER	Metamorphic rock, mainly quartzo-feldspathic gneisses.
CHURCHILL PROVINCE		
C3	HELIKIAN	Supracrustal sedimentary and volcanic rocks of the Seal Group.
C2	APHEBIAN	Sedimentary and volcanic rocks of the Labrador Trough.
C1	APHEBIAN AND EARLIER	Metamorphic rocks, mainly quartzo-feldspathic gneisses and granulites.
NAIN PROVINCE		
B4	HELIKIAN	Supracrustal sedimentary and volcanic rocks of the Ramah and Mugford Groups.
B3	HELIKIAN AND APHEBIAN	Supracrustal sedimentary and volcanic rocks of the Croteau Group.
B2	APHEBIAN	Metamorphosed sedimentary and volcanic rocks of the Aillik Group.
B1	ARCHEAN	Basement gneisses.
SUPERIOR PROVINCE		
A	ARCHEAN	Granulitic gneisses and acidic intrusives.

INTRUSIVE ROCKS

4	HELIKIAN	Anorthosites: gabbros and associated acidic intrusives.
3	HELIKIAN AND EARLIER	Massive to poorly foliated acidic intrusives.
2	APHEBIAN	Acidic intrusives and associated metamorphic rocks.
1		Gabbroic sills.

STUDY OF THE ALKALI REACTIVITY OF POTENTIAL AGGREGATES OF NEWFOUNDLAND

Date: JAN 1989
Project: 861-5024

Golder Associates

Drawn: J.M.C.
Chkd:

5.0 AGGREGATE SAMPLING AND PHYSICAL TESTING PROGRAM

5.1 Overview

A significant component of this study included a series of laboratory tests to evaluate the potential for alkali aggregate reaction of selected aggregate samples. The principal techniques applied included petrographic examination to determine the mineralogy of the samples, and volume change determinations of mortar/aggregate specimens to evaluate potential reactions between the aggregates and cement alkalis.

Shortly after receipt of the initial group of samples, it became apparent that relatively little data was available on the basic physical properties of the rock types and aggregates submitted. To address this deficiency, the original testing program was modified somewhat to include several routine laboratory tests to evaluate the durability characteristics of the submitted samples.

The samples which satisfied typical durability test criteria for concrete aggregates were then examined petrographically to determine deleterious constituents. The procedures followed for each aspect of the Phase I laboratory testing program are outlined in the following subsections. The majority of the aggregate samples were subsequently tested for volume change characteristics in long term mortar bar or concrete prism specimens.

5.2 Aggregate Sample Procurement

The aggregate samples included in this study were primarily acquired and selected by personnel of the Newfoundland Department of Mines. The samples, from a total of 35 different local sources, are grouped into two general categories to satisfy the two main objectives of the Department as follows:

a) A number of existing ready mix concrete producers throughout the province. These samples represent a cross section of aggregates currently in use. Samples were obtained from 14 of the 22 known ready mix producers in Newfoundland and Labrador.

b) A selection of materials from several potential sources of fine and coarse aggregates in the vicinity of the head of Placentia Bay (Come-by-Chance/Swift Current area). These samples are considered representative of materials which may be considered for offshore concrete platform construction. A total of 15 samples were submitted from this area including ten sand samples and five bedrock samples.

Samples from the ready mix producers were generally obtained from product stockpiles at the batch plants, which have generally been identified as the sample source for lack of more definitive information. The majority of these samples were collected in 1986. The samples from the head of Placentia Bay (Swift Current area) were mainly collected in 1985 during a general sampling program conducted by the Department of Mines, and were obtained from natural exposures and hand dug pits along the shoreline. In several cases, supplementary samples were acquired by Golder Associates personnel from locations not previously sampled which were considered significant to the study, and could be conveniently obtained. These included four from ready mix producers and two from the head of Placentia Bay.

In addition to the local aggregate samples collected for this study, several control samples with known alkali reaction characteristics were also included in the expansion test program. The reference samples included coarse aggregate from the following well known sources: Spratt limestone, Sudbury gravel and Pittsburg dolomite-limestone. These standard samples were obtained from the Ontario Ministry of Transportation in Downsview, Ontario. Non-reactive fine aggregate used for concrete prism fabrication was obtained by Golder personnel from an approved source in Guelph, Ontario.

The aggregate samples used are identified throughout this study by the numbers originally assigned by the Department of Mines. These numbers, the general location, and the sample source are summarized in Table I.

5.3 Routine Physical Properties

A comprehensive laboratory program of routine tests was undertaken to establish the basic physical properties of the aggregates. The results of these tests are summarized on an Aggregate Summary Sheet for each sample in Appendix 'B'. A comment following the tabulation of results indicates the general suitability of the sample as concrete aggregate, or other aspects which may have affected the test results.

The laboratory tests conducted on each sample typically included bulk relative density and absorption (ASTM C127/128), Los Angeles Abrasion (ASTM C131, C535) and Sulphate Soundness (ASTM C88), where sufficient material was available. For a number of samples a chemical stability test (ASTM C289) was also conducted.

5.4 Chemical Stability

ASTM C289 outlines a method of determining the chemical reactivity of siliceous aggregates, using a sodium hydroxide solution. A total of 27 samples were tested by the Nova Scotia Research Foundation, with the results presented in 'Appendix B'. Five samples, all from the Adam's Head area, are indicated by this test to be potentially deleterious. It was suggested by the Scientific Authority during the test program that remaining samples need not be subjected to this test.

STUDY OF THE ALKALI REACTIVITY OF POTENTIAL CONCRETE AGGREGATE OF NEWFOUNDLAND

TABLE 1

AGGREGATE SAMPLE LOCATIONS & SOURCES

SAMPLE NO.	LOCATION	SOURCE
85-3006	Swift Current, P.B.	Test Pit
85-3008	Swift Current	Test Pit
85-3017	Swift Current	Test Pit
85-3032	Swift Current	Test Pit
85-3047	Swift Current	Test Pit
85-3050	Swift Current	Test Pit
85-3058	Swift Current	Test Pit
85-3065	Piper's Hole, P.B.	Test Pit
85-3066	Piper's Hole	Test Pit
85-3161	Black River Point	Test Pit
85-6200	Adam's Head, P.B.	Coastal outcrop
85-6213	Adam's Head	Coastal outcrop
85-6214	Adam's Head	Coastal outcrop
85-6215	Adam's Head	Coastal outcrop
85-6216	Adam's Head	Coastal outcrop
86-6001	Holyrood, C.B.	Concrete Products
86-6002	Port aux Basques	Sheaves Concrete
86-6003	Stephenville Crossing	Western Const.

TABLE I (cont'd)

86-6004	St. Anthony	New Airport Site
86-6005	Stephenville	N&L Construction
86-6006	Gallants	Lundrigans Pit
86-6007	Springdale	Hewletts Quarry
86-6008	Grand Falls	Hunts Concrete
86-6089	Lewisporte	Central Ready Mix
86-6090	Butts Pond	McCurdy Ready Mix
86-6091	Eastport	Alkeith Const.
86-6093	Goose Bay	Unknown
86-6094	Marystown	Burin Ready Mix
86-6095	Clarenville	Eastern Ready Mix
86-6096	Wabush	G.P. Construction
88-GA01	Seal Cove	Mac Mix
88-GA02	St. John's	Atlantic Concrete
88-GA03	Mackinsons	Dawe's Concrete
88-GA04	Pipers Hole, P.B.	Adams Aggregates
88-GA05	Swift Current	Roadside outcrop
CONTROL SAMPLES		
Inert Sand #1	Guelph, Ont.	Standard Aggregates
Inert Sand #2	Guelph, Ont.	Standard Aggregates
Pittsburg	Kingston, Ont.	OMT Central Lab.
Sudbury	Sudbury, Ont.	OMT Central Lab.
Spratt	Stittsville, Ont.	OMT Central Lab.

5.5 Petrographic Examination

5.5.1 Particle Count Method

Each sample was examined petrographically to generally determine the constituent mineralogy. A petrographic examination of a representative sub sample was initially conducted. Samples or constituents which were complex or potentially deleterious were then examined in thin section. More sophisticated or comprehensive techniques for mineralogical examination are beyond the scope of this study.

ASTM C295 outlines the examination procedure using a stereoscopic microscope to examine various sieve fractions. The standard recommends at least 300 particles from each size fraction to be lithologically classified. The Standard Descriptive Nomenclature recommended by ASTM C294 was followed as closely as possible. Each classification is described in terms of particle shape, color, and comments are made on the occurrence of intense alteration, clay coatings or any feature which may be physically deleterious. This procedure is designed primarily to provide a reasonably accurate petrographic assessment of the total sample.

5.5.2 Thin Section Analysis

The purpose of the thin section analysis was twofold:

1. to verify lithological classifications obtained by the Particle Count Method (ASTM C295)
2. to determine the approximate proportion of strained quartz in granitoid rocks and clastic sediments.

A total of 25 thin sections were examined. The majority of these included 3 or 4 individual particles from a single sample which were carefully selected to be representative.

The method of analysis used facilitates a reasonably detailed assessment of the constituent mineralogy. The degree of alteration, the abundance of platey minerals, and the crystal structure of the silica minerals were determined during this procedure.

Although this analysis method provides considerable detail, it is not always definitive, especially when examining small fragments and/or very fine grained rock types.

5.5.3 Constituent Terminology

ASTM C294 was utilized for the lithological classification of constituents. This standard does not provide the detail necessary to adequately classify many of the lithologies encountered. The following is a list of the constituents noted which were not listed in ASTM C294, accompanied by a brief explanation.

Felsic Volcanic - this term is used partially synonymously with 'felsite' ASTM C294 (para. 17.3). Many felsic volcanics are not light coloured and fine grained, and may exhibit tuffaceous textures. Rhyolites (and dacites) which may be clearly identified have been, and thus technically form a subset of this grouping.

Volcaniclastic - this term is not mentioned in ASTM C294 and has been used to describe particles which are clastic and contain volcanic material, in whatever proportion, without regard to its origin or environment. The term is generally used in conjunction with the mafic or felsic volcanic component.

Mafic Volcanic - is comprised primarily of dark green to black fine grained medium to soft volcanic rocks. The primary lithology is basalt but it may also encompass andesites and their metamorphic equivalents. Basalts which may clearly be identified as such have been, and therefore form a subset of this grouping.

Tuffaceous Sediment - this is an arenite displaying tuffaceous textures. This lithology is generally hard and light in color. Examples of common rock types encountered, but not specifically listed in ASTM C294 are arkose, diabase and granodiorite.

5.6 Criteria for Categorization

Each sample has been generally categorized in terms of its overall potential for expansive reactivity. This grouping is based on percentages of the various constituents in accordance with the following groupings:

Coarse Aggregate/Rock

1. Sedimentary rocks, their metamorphic equivalents, siliceous volcanogenic rocks containing microcrystalline quartz or cryptocrystalline silica.
2. Carbonaceous Rocks
3. Plutonic rocks containing unstrained quartz, basic volcanogenic rocks and their metamorphic equivalents free of cryptocrystalline silica.

Fine Aggregate/Sand

1. Sedimentary rocks, their metamorphic equivalents, siliceous volcanogenic rocks containing microcrystalline quartz or cryptocrystalline silica.
2. Carbonaceous rocks.

3. Crystalline or unstrained quartz, feldspar, other minerals, plutonic rocks containing unstrained quartz, basic volcanogenic rocks and their metamorphic equivalents.

4. Cryptocrystalline silica, strained quartz.

These groups of potentially reactive components which may be identified in the aggregate sources examined are predicted to react in the following manner:

Group 1 - responsible for alkali-silicate reactions: argillites, greywackes rich in chlorite and clay minerals, slates and sandstones rich in strained quartz. For the alkali-silica reaction:- sandstones rich in cryptocrystalline silica as grains and cement, siliceous volcanogenic rocks, slates rich in strained quartz and phyllosilicates and granitoid rocks rich in strained quartz.

Group 2 - encompasses limestones and dolomites which may be involved in alkali-carbonate reactions.

Group 3 - contains rocks and minerals usually defined as chemically inert.

Group 4 - may be responsible for alkali-silica reaction.

The resulting categorization of each sample is included on the Aggregate Summary Sheets in Appendix B in both tabular and graphical form.

5.7 Data Presentation

This section outlines the format in which the test results and other data have been presented in this document.

5.7.1 Aggregate Summary Sheet

These sheets comprise Appendix B, and are intended to provide a quick reference summary of the main physical and petrographic parameters of each sample. A general assessment is also included on the potential for expansive reactivity. The following paragraphs elaborate on various details of this form.

Sample No. complies with those supplied by the Department of Mines with the exception of the samples obtained by Golder Associates personnel. The source and type headings give the sample location and the physical description respectively.

Physical Properties are quoted on the basis in terms of the ASTM procedure followed. In the case of L.A. Abrasion Loss, two standards are available:

1. C 131 applies to small-sized coarse aggregate
2. C 535 applies to large-sized coarse aggregate.

The results of C131 are recorded on the Aggregate Summary Sheets. If C535 was performed, the results are presented in the comments section.

The absence of test results, particularly soundness and abrasion values, is due to unavailable grading sizes of samples and/or a lack of sufficient sample material.

Petrographic Examination results (ASTM C295) are presented in a qualitative manner in order to provide a general summary of the constituents of the sample, thereby avoiding the statistical detail associated with the particle count method. The categories indicated are based on the proportionate volume of the constituents of each sample as follows:

Major	>50	percent
Intermediate	35 - 50	percent
Minor	10 - 35	percent
Trace	<10	percent

When more than one constituent is grouped in a particular category they are quoted in terms of descending abundance, i.e. the most abundant constituent is quoted first. The proportions of particular constituents vary slightly from fraction to fraction. It is stressed that this is a qualitative summary and partially subject to the author's disgression. For the detailed particle count analysis results the reader is referred to Appendix C.

5.7.2 Graphical Categorization Summary

The results of the assessment for potential expansive constituents in each sample has also been graphically illustrated in Appendix B. These bar charts provide a quick reference summary of the constituent groupings presented on the Aggregate Summary Sheets.

5.7.3 Particle Count Tables

These tables present the results of the stereoscopic petrographic analysis and are based on ASTM C 295 - Petrographic Examination of Aggregates for Concrete. The tables provide detailed descriptions of the constituents and estimated percent volumes based on representative sieve fractions. Additional information is provided in the notes preceding the tables in Appendix C.

5.7.4 Thin Section Analysis

This analysis is presented in Appendix C in two sections:

1) detailed petrographic analysis supplied by a specialist sub-consultant.
2) general mineralogical analysis performed by Golder Associates personnel.

Thin sections were cut from fragments which were difficult to classify during the particle count analysis. Granitic samples also were examined in order to obtain an estimate of the strained quartz content.

Section I contains a total of 14 descriptions from 10 samples, which are presented as received from the consultant. Each sample contains a 'Comments' section which includes a summary of observations and general comments relating to the author's views on the potential for reaction. These opinions should therefore be treated with caution.

Section II contains a total of 17 descriptions from 16 samples. This analysis is brief, and was intended to be a follow-up verification of the potentially deleterious fragments, especially felsic volcanic and granitoid lithologies. Therefore only the basic mineralogy is verified. The presence of deleterious components such as strained quartz is noted.

5.8 Test Results and Discussion - Phase I Program

The physical properties of the aggregates tested show a moderate variation in terms of abrasion loss and soundness loss. Abrasion losses typically vary between 10 and 20 percent.

Soundness loss values are typically less than 1 percent and with two exceptions (Samples 85 3006, 85 3032) are less than 2 percent. Relative density values generally range between 2.60 and 2.80.

Absorption values for coarse aggregate are typically between 0.0 and 1.0 while values for fine aggregate are higher and generally range between 1.0 and 2.0.

In summary, these properties indicate that the samples provided and tested are generally suitable for use as concrete aggregate.

Aggregate samples provided from the ready mix concrete producer sources had wide spread distribution across the province. However, the specific origin (rock type and geological formation) often could not be determined, and thus correlation with the potential reactivity of the aggregate was generally impractical.

The majority of the samples from ready mix concrete producers were obtained from non-bedrock sources. The constituent rock types and mineralogy are thus considerably more variable and complex than is typically found in a bedrock source.

The petrographic examination results illustrate the wide variety of rock types and minerals observed in these samples. An interpretation of the consequences of various lithologies in terms of potential alkali reactivity is often unclear and somewhat subjective.

The primary focus during the petrographic assessment was the quantity and crystal form of quartz and/or silica minerals. The condition of quartz can usually be clearly assessed by means of a thin section analysis, however, in this study it was not practical to mount representative quantities of quartz/silica minerals from all samples.

The analysis of silica minerals using the stereoscopic microscope does not give a clear indication of the crystal structure and size. Therefore definitive identification of the following deleterious minerals could not be obtained:

1) Tridymite and cristobalite are metastable, high temperature silica minerals. These minerals are generally found only in recent volcanic rocks, and are therefore not considered likely to occur in the samples provided.

2) Cryptocrystalline varieties of silica minerals, generally grouped as chalcedony, are distinguished from quartz based on their occurrence and habit. Chalcedony is precipitated from silica bearing solutions and hence forms cavity linings, veins and replacive masses in a variety of rocks. It typically is botryoidal and in structure is commonly banded.

It is believed that greater than 90 percent of the silica minerals observed are normal (weakly strained) crystalline quartz, however this is based on general observation and not a detailed analysis.

Immersion media were used in an attempt to distinguish between various silica minerals. This method was found to be very time consuming and yielded unclear results.

6.0 SPECIMEN EXPANSION TESTING PROGRAM

6.1 Overview

The performance of the aggregate materials sampled in a series of laboratory volume change (expansion) tests is the major component of this study. As discussed in Section 5.1, the samples provided which met conventional durability criteria and were available in sufficient quantity, were used to produce mortar bar and/or concrete prism specimens. A total of 25 sets of mortar bars and 21 sets of concrete prisms were made and subjected to long term storage and periodic length measurement. Both bars and prisms were tested for 12 of the samples. An additional three sets of bars and three sets of prisms were tested for the control samples.

This section describes the materials, equipment and procedures used to fabricate, store and test the volume change (expansion) specimens.

6.2 Criteria for Mortar Bar Versus Concrete Prism Testing

The decision of whether to cast mortar bars (ASTM C227) or concrete prisms (CSA A23.2-14A) was based on the results of the petrographic analysis. These results enable the petrographer to initially classify a sample in terms of its potentially deleterious constituents. The main reference guide used for this evaluation were the flow charts illustrated in CSA CAN3-A23.2-M77, Appendix B, Rev. October 1986, Figures B1, B2 and B3.

The following is a brief listing of the rock type groupings which are thought to cause expansive reactions:

1. Alkali Silica Reaction - all rocks containing metastable or cryptocrystalline silica and/or volcanic glass. The primary lithologies which fall into this group are: volcanic rocks - principally felsic volcanics: rhyolites, dacites and tuffs.

2. Alkali Silicate Reaction - all rocks rich in phyllosilicates (sheet silicates) and/or strained quartz. These include a wide range of rock types, but principally include: granite, quartz arenite, quartz- wacke, quartzite, argillite, phyllite, greywacke, arkose, and/or sandstone.

3. Alkali Carbonate Reaction - all rocks containing high quantities of limestone, dolomitic limestone, or dolomite.

Several samples were tested for expansion in both mortar bar and concrete prism specimens. These samples include those for which both expansion mechanisms may apply. Samples which are indicated to be non-reactive from petrographic analysis, were tested using the mortar bar method to verify this conclusion.

A summary of the specific samples used to make the mortar bar and/or concrete prism specimens is provided in Table D.1 of Appendix D.

6.3 Materials

6.3.1 General

The mortar bars and concrete prisms were fabricated from locally-produced Portland cement, water and the selected aggregates. The means of sample procurement are outlined in Section 5.2. The following sections describe the materials used and related preparation details.

6.3.2 Aggregate

Bedrock & Coarse Aggregate

Bedrock samples were all crushed in a laboratory jaw crusher and separated into the required size fractions by manual sieving. Most of the coarse aggregate and bedrock samples were used for the manufacture of prisms, however several samples were crushed to sand size when insufficient quantities were available and were tested as fine aggregate in mortar bars. The preparation of concrete prisms required washing and drying of the coarse aggregate. Non-reactive Guelph Sand was used as the fine aggregate for the manufacture of concrete prisms.

Sand

Mortar bars were fabricated from the sand samples procured, or from suitably-crushed coarse material. The sample was sieved mechanically into the required gradations and weighed and stored prior to mixing.

6.3.3 Cement

North Star Portland cement, Type 10, was used for the fabrication of both concrete prisms and mortar bars. All cement used in this project was obtained from the same batch and supplied in bags. This cement has a total alkali content (Na equivalent) of about 1.23 percent, and thus no supplemental increase of this constituent was provided. The chemical analysis of this cement is provided in Table 2, as provided by the manufacturer.

TABLE 2

NORTH STAR CEMENT LIMITED

PORTLAND CEMENT
AREA CODE 709
PHONE 634-8251

CORNER BROOK
NEWFOUNDLAND
A2H 6C7

MASONRY CEMENT
P. O. BOX 160
TELEX 016-44118

DATE: May 18, 1988

CEMENT TEST REPORT

SAMPLE: Golder Assoc. for A.A.R. Testing

CHEMICAL:

Loss on Ignition	1.90
Insoluble Residue	0.50
Sulphur Trioxide	4.01
Tri-calcium Aluminate	5.56
Silica Dioxide	21.49
Ferric Oxide	3.56
Alumina	4.37
Calcium Oxide	59.71
Magnesium Oxide	3.67
Total Alkalies (Na equiv.)	1.23
K_2O	1.07
Na_2O	0.53

PHYSICAL:

Fineness	95.0
Soundness	0.18
Sulphate Expansion	0.015
Setting Time	120 min.

COMPRESSIVE STRENGTH:

3 Day	19.3	MPa
7 Day	24.2	MPa
28 Day	32.4	MPa

NOTE: Tests in accordance with Can. 3-A5-M83

Robert E. Collins

Robert E.Collins, Plant Chemist

CUSTOMER: ______________________

____

6.3.4 Water

St. John's tap water was used for all prism and mortar bar batches. The temperature was recorded as required.

6.4 Equipment

6.4.1 General

The equipment used during this project was manufactured in general accordance with the requirements outlined in the relevant CSA and ASTM Standards. This section briefly describes and identifies the equipment used.

6.4.2 Moulds and Tamping Rods

Prism moulds were manufactured by a local machinist and are made of mild steel. The moulds have inside dimensions of 330 x 75 x 75 mm. Gage studs, 5 mm in diameter, 28 mm in length, generally extend into the specimen 19 mm, and are 292 mm apart. The moulds meet the requirements outlined in Figure 1 of CAN3-A23.2-14A, revised October 1986. The mortar bar moulds were obtained from a commercial supply house.

The mortar bar moulds have inside dimensions of 285 x 25 x 25 mm. Gage studs, 6 mm in diameter and 21 mm in length each extend into the specimen 11 mm with the tips 263 mm apart.

Tamping rods used to compact the mortar and concrete met the dimensional requirements of the appropriate standards. A standard flow table and slump cone were utilized to check the water/cement ratio, as stipulated by ASTM C227.

6.4.3 Mixers, Oven and Scales

The mortar for the bars was mixed in a Hobart Model N50 mixer with a 5.7 litre bowl capacity. The concrete for the prisms was mixed in a 0.085 cubic meter capacity portable electric Monarch mixer.

The oven was manufactured by M & L Testing (Model 21-350-3), and has a maximum temperature capacity of 550°C.

Three scales were used during this project:

1) 22.5 kg capacity - Ohaus balance accurate to 0.1 gm
2) 2610 gm capacity - Ohaus Dial-O-Gram, accurate to 0.01 gm
3) Mettler PE 3600 - Delta range electronic balance accurate to 0.01 gm.

6.4.4 Specimen Storage Containers

The concrete prism and mortar bar storage containers are very similar in design. The container is a white polyurethane bucket 0.43 m high and 0.30 m in diameter, with 5 mm thick walls. Both the bars and the prisms are supported on 10 mm square wire mesh, which is raised from the base of the container by a 15.5 m diameter 50 mm high plastic ring. A second wire mesh located near the top of this container serves to restrain the top end of the bars and prisms. Two sizes of this wire mesh (50 mm and 10 mm) were necessary to accommodate the size difference of the mortar bars and prisms. Covers are made of 20 mm thick marine plywood with a foam rubber gasket to ensure a tight seal with the bucket rim. A weight is kept on top. Paper wicks are maintained along the sides of the buckets and the bottom 30 mm is kept full of water.

6.4.5 Length Comparators

A specialized length comparator was manufactured for this project. The comparator for length change measurement of the concrete prisms was fabricated by a machinist in New Brunswick in accordance with the requirements illustrated in Figure 2 of CAN 3-A23.2-14A, Rev. October 1986. The comparator was fitted with a Mitutoyo Digimatic indicator, accurate to within 0.0001 in.

The mortar bar comparator was obtained from a commerical supplier. If mounts the bars vertically and is similar to that illustrated in ASTM C490. This comparator is equiped with a Humboldt Mfg. Co. analog indicator, accurate to 0.0001 in.

The major difference between these comparators is that the prism comparator supports prisms on a steel bracket and the gage stud is held in place at the base by means of a counterweight. With the mortar bar comparator the gage stud rests directly upon the base of the comparator and therefore takes the weight of the bar. The top gage stud is held in place by means of a spring mechanism for both comparators. The standard reference bars were made of 12.5 mm diameter invar steel.

6.4.6 Moist Curing Room

The moist curing room is maintained at 100 percent humidity and a temperature of 23 ± 2°C. A section of the existing concrete cylinder storage room was adapted for concrete prism and mortar bar storage. The temperature is monitored by two M & L Testing Ltd., Maximum - Minimum Thermometers.

6.4.7 High Temperature Room

A dry, high temperature storage room was used for storing the sealed mortar bar and concrete prism storage containers. The room was constructed specifically for this project, and is approximately 2.8 x 1.9 x 1.3 m in dimensions. The room is heated with an electric baseboard heater with a Pyrotenax 50°C (maximum) thermometer. The room has a capacity of approximately 40 buckets, and was maintained at a temperature of 38 ± 2°C.

6.5 Casting of Specimens

6.5.1 Specimen Identification

The numbering system adopted by the Department of Mines and Energy during field sampling has been maintained throughout the study. Five additional samples which were collected by Golder Associates personnel have been designated as 88 GA01 to 88 GA 05.

6.5.2 Mix Design and Casting Procedure - Prisms

Mix designs and prism casting procedures were in accordance with CSA A23.1 - M77 - 14A, and mortar bars were cast in accordance with ASTM C227-87.

The concrete prisms were fabricated using the following theoretical proportions for a set of three prisms:

Cement	-	1.692 kg
Fine aggregate	-	4.530 kg
Coarse aggregate	-	5.600 kg(in 3 equal fractions)
Water	-	1.092 kg

The amount of water was adjusted slightly in order to obtain a slump of 80 ± 10 mm. The measured components deviate slightly from the amounts indicated.

6.5.2.1 Batching

Sand and coarse aggregate for the concrete prisms were weighed in a dry condition on the Ohaus balance sensitive to 0.1 g, and were then saturated for 24 hours. The cement and mixing water were also weighed on the Ohaus balance prior to mixing. The moisture content of each aggregate type was determined before batching of each set of prisms. This water was combined with the water added to the batch and a total weight determined.

6.5.2.2 Mixing

Batches of 0.25 m^3 were produced in the tilting concrete mixer. The basic procedure was as follows:

1) the coarse and fine aggregate and cement were blended for about two minutes

2) the water was then added with the mixer running

3) the contents of the drum were mixed for about three minutes.

4) the mixer was allowed the stand for three minutes, during which time the slump was measured. If any additional water was required, the mixer was restarted, an appropriate amount added, mixed thoroughly and the slump rechecked.

5) the prisms were cast directly from the mixer.

6.5.2.3 Casting of Specimens

The prism moulds were sprayed with a thin film of oil prior to casting. The moulds were filled in two layers. These layers were compacted using a standard tamper. Special attention was necessary to ensure that the concrete was consolidated uniformally around the corners of the mould and around the gauge studs.

After tamping each layer, the top and edges of the mould were levelled and cleaned. During this process, a rubber hammer was used to strike the side of the mould to close the voids. Upon completion of the casting, the specimens were placed in the moist curing room and covered with a polyethylene sheet for 23 1/2 ± 1/2 hours.

The prisms were then demoulded and placed in a water bath at 23 + 2°C for 30 ± 5 mins as per CAN3-A23.2-14A. Upon removal from the water, each prism was marked with an identification number and an arrow at one end. The prisms were then measured, establishing their initial length, and placed in a container under the appropriate storage conditions.

Compressive strength cylinders were cast from the mix for several specimens and then cured and tested in accordance with CAN3-A23.2-3C/-9C.

6.5.2.4 Cleaning Equipment

All of the containers, the mixer, slump cone and mixing utensils were washed and dried after every batch. The prism moulds were dissembled and cleaned thoroughly in water after use. After cleaning, the moulds were reassembled.

6.5.3 Mix Design and Casting - Mortar Bars

The following mix proportions were used for the mortar bars:

Cement	-	0.30 kg
Fine aggregate	-	0.675 kg

Water was added to produce a flow of 105 to 120 mm at a rate of 10 drops in 6 seconds (as per ASTM C109).

The quantity of water ranged from 140 to 210 grams. These mix proportions were used for one batch, with two batches required for a set of four bars.

6.5.3.1 Batching

The sand, cement and water were weighed using a digital balance accurate to 0.1 gram.

6.5.3.2 Mix

Batches of 0.005 m^3 were produced in the Hobart mixer. The basic procedure was as follows:

1) the aggregate and cement were blended for about two minutes
2) an appropriate amount of water was added in order to achieve the required flow
3) the contents of the mixer bowl were mixed for about three minutes

6.5.3.3 Casting of Specimens

Prior to casting the moulds were sprayed with a thin film of oil. The mortar bar moulds were filled in two layers. Each layer was tamped, with special attention around the gauge studs and corners of the mould. The mortar was levelled at the top and the excess mortar removed from the sides of the mould. The mortar bars were then placed in the moist room at 23°C and covered with a plastic sheet for 24 ± 2 hours. After demoulding, the samples were appropriately labeled and placed in a container for storage in the moist room.

6.5.3.4 Cleaning Equipment

All containers and instruments were washed with water and dried immediately after completion of each set of bars. The moulds were disassembled and cleaned after each sample.

6.6 Specimen Storage

The specimens for all but three samples were stored in the high temperature room continuously, except when being cooled and measured. Specimens made from carbonate rock samples were stored in the moist curing room.

6.7 Length Measurement

The mortar bars and prisms were removed from their respective storage environments for length measurement at predetermined time intervals. The respective time schedules are indicated on the relevant data sheets presented in Appendix D.

6.7.1 Prism Measurements

The accelerated test prisms were removed from the high temperature storage room and cooled in their containers in the moist room for 20 to 24 hours prior to measurement. The specimens cured in the moist room were immersed in water at 23 ± 2°C for 30 ± 5 minutes prior to measurement.

Before length measurement, the gauge studs and comparator seats were carefully cleaned. The invar reference bar was then placed in the comparator, and rotated at least 360° to insure that it was seated properly. Concrete prisms were measured using a similar procedure. Measurements were made to the nearest 0.0001 inch and recorded on appropriate laboratory forms.

6.7.2 Mortar Bar Measurements

Mortar bars were removed from the high temperature room and cooled to 23°C for a period of 16 to 20 hours. Before measuring the length of each specimen, the gauge stud seats were examined to ensure no dirt build up and the mortar bar studs were cleaned. The invar bar was carefully mounted in the apparatus and rotated 360° to ensure it was seated properly. The dial gauge was zeroed on 0.2000 in., so that negative readings could be accommodated. The mortar bars were placed in the comparator in a similar manner as the invar bar. All measurements were recorded to the nearest 0.0001 inch and recorded on appropriate forms.

6.8 Calculations and Plotting

The difference in length between the specimen and the reference bar was obtained directly from the digital micrometer for the concrete prisms and the analog gauge for the mortar bars.

These readings were keyed directly into the appropriate cells of a purpose-made computer spreadsheet. Individual measurements were subtracted from the initial reading (i.e. at day 1) and the difference expressed as the percent elongation. The average percent elongation for each suite of specimens was then calculated for each time interval.

The average percent elongation for each suite has been plotted against selected time intervals by a simple plotting program.

6.9 Data Presentation

This section outlines the format in which the mortar bar and prism expansion data is presented in Appendix D.

6.9.1 Spread Sheet

Elongation readings for each specimen of a set are presented in tabular form for each time interval at which they were recorded. The calculated difference of each measurement from the original reading is also indicated in each case as percent elongation. The average percent elongation for each set of specimens is also shown. The tables also contain the constituent weights for the particular mortar or concrete batch.

6.9.2 Expansion Graphs

The average percent elongation for each suite of mortar bars and prisms is presented in graphic format against a regular time interval of four weeks for the mortar bars, and four, eight and 20 weeks for the prisms.

6.10 Test Results and Discussion - Phase II Program

The majority of the 25 samples tested in mortar bars exhibited slight to moderate expansion (0.02 to 0.04 percent in 6 months). The maximum expansion recorded was 0.04 percent for several samples.

For the control samples a 0.06 percent expansion was recorded for bars made from crushed Spratt limestone while expansions of 0.02 and 0.03 were measured for Guelph Sand.

Slight to moderate expansion in the range of 0.005 to 0.015 percent or less was obtained in 16 of the 21 prism samples tested. Five of these samples exhibited very low expansion. The remaining five prism samples recorded slightly higher expansions of about 0.02 percent for one year.

Expansions of 0.015 and 0.02 percent were measured for the Sudbury and Spratt control samples, while a value of 0.07 percent was obtained for Pittsburg dolomite-limestone.

The apparatus used and procedures followed in the mortar bar tests produced repeatable results. It is apparent, however, that the actual storage conditions strongly influenced the length changes recorded for the bars. Although similar care and procedures were used for the concrete prism specimens it was consistently more difficult to obtain repeatable results with the standard, vertical comparator.

7.0 CONCLUSIONS

One objective of this study has been reasonably well satisfied. The aggregates being used by most ready mix concrete producers have been tested to determine their potential reactivity with cement alkalis. However, aggregates from all producers in the province have not been tested.

A second objective of determining the potential for alkali aggregate reaction in granular and bedrock formations near the head of Placentia Bay has been partially met.

A third objective of correlating rock types with their potential for alkali aggregate reaction was partially achieved in only one localized area of the province.

The budget limitations of this project restricted the scope of sampling, testing and related activities to the immediate areas of interest studied. However, the findings of this project have provided a reasonably good overview of the general degree to which this phonomena has and may develop.

Although this study did not meet all the stated objectives, the following conclusions have been drawn from the information obtained:

1) Aggregates currently used by ready mix concrete producers generally have satisfactory durability characteristics as determined by routine laboratory tests.

2) Aggregates currently used have low to moderate potential for alkali aggregate reactivity as determined by conventional laboratory mortar bar and prism tests. All samples tested recorded expansion values within the acceptable limits indicated in Table B1 of Appendix B, Rev. 1986, of CAN3-A23.1-M77, the "Suggested Maximum Expansion Values for Various Test Methods for Alkali-Aggregate Reactivity."

3) Most rock types and granular deposits in the head of Placentia Bay - Clarenville area exhibit slight to moderate alkali aggregate reaction potential in the standard tests. Some samples recorded low reaction potential.

4) Evidence of moderate to strong alkali aggregate reaction has been confirmed by petrographic examination of core samples from 5 of 8 concrete structures examined within the head of Placentia Bay - Clarenville area.

5) Little direct evidence of alkali aggregate reaction has been observed in concrete structures on the Avalon Peninsula. Limited opportunities have been available to make visual assessments of suitable age concrete because of the current maintenance program to cosmetically repair bridge structures. However, on the basis of samples examined from other projects and visual observations, occassional indications of slight to moderate alkali aggregate reaction have been noted.

6) Deterioration of 15 to 30 year old concrete highway structures is common in this province. Where general deterioration has occurred, surficial evidence of alkali aggregate reactivity may be suppressed by other features. Sampling and detailed examination of the concrete would thus be necessary to confirm the presence of this phenomena.

7) There is limited awareness of the alkali aggregate reaction phenomena in this province, and no documentated cases are known. Since dramatic evidence has not been reported from structures, it is concluded that highly reactive aggregates probably have not been used to date.

8) Petrographic descriptions of the samples tested illustrate the wide variety of rock types commonly present in many non-bedrock sources of aggregates presently used in ready mix concrete. Tracing individual fragments and rock types to bedrock formations requires a broad familiarity with local geology and detailed sample data.

Conclusions from the findings of this study are restricted by the number and type of samples provided, limited location data available for some samples, and the limited number of concrete structures which have been examined and sampled, which has been restricted to the southeast corner of the province. In addition, no concrete in dams or marine structures has been examined.

8.0 RECOMMENDTIONS

Experience from this study has demonstrated that data more applicable and useful to the objectives of this study would be obtained with the following modifications:

1) Laboratory tests carried out on aggregate or prospective aggregate samples can only be related to a particular rock type or formation if the original source location of the sample is adequately identified. Where fine and coarse aggregates are being obtained from different sources this information must, of course, be obtained for both. Photographs and geological descriptions of the source locations would be beneficial.

2) In cases where the objective of a study is to evaluate potential sources of aggregate within a given area, an overall sampling program should be carefully planned in relation to the local geology. This program should ensure that representative sampling of all significant formations and rock and granular units which are relevant to the study is undertaken. Using this procedure pertinent rock and granular units should not be overlooked in an area-wide evaluation.

3) To obtain a comprehensive appreciation of the extent and severity of alkali aggregate reactivity in this province, a broad based and representative concrete sampling and detailed examination program should be undertaken. Such a program should include samples from concrete dams and marine structures. In view of the extent of surficial repairs which are typical on local concrete structures more than 15 years old, such a sampling program is necessary to suitably evaluate the performance of aggregates in concrete bridge structures.

4) To achieve the overall objective of correlating rock types and formations throughout the province with their potential for alkali aggregate reactivity systematic and integrated sampling programs must be coordinated with mapping and testing on a broad scale. Geological sampling should be concentrated in bedrock units with locations adequately established. Representative sampling and petrographic examination of concrete structures should be carried out so that performance of a broad distribution of rock types in concrete can be assessed.

5) Difficulties were encountered during this project obtaining repeatable length measurements on concrete prism specimens using the vertical comparator. An alternate design for the comparator should be considered which will facilitate repeatable measurements.

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C-29-78	Test for Unit Weight and Voids in Aggregate
C-33-82	Specifications for Concrete Aggregates
C-88-76	Test for Soundness of Aggregates by Use of Sodium Sulfate and Magnesium Sulfate
C-125-82	Definitions of Terms Relating to Concrete and Concrete Aggregates
C-127-81	Test for Specific Gravity and Absorption of Coarse Aggregate
C-128-79	Test for Specific Gravity and Absorption of Fine Aggregate
C-131-81	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C-136-82	Sieve Analysis of Fine and Coarse Aggregates
C-227-81	Test for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar Bar Method)
C-289-81	Test for Potential Reactivity of Aggregates (Chemical Method)
C-294-81	Descriptive Nomenclature of Constituents of Natural Mineral Aggregates
C-295-79	Standard Practice for Petrographic Examination of Aggregates for Concrete

C-535-81	Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C-702-80	Reducing Field Samples of Aggregate to Testing Size
C-823-81	Standard Practice for Examination and Sampling of Hardened Concrete in Construction
C-856-77	Standard Recommended Practice for Petrographic Examination of Hardened Concrete
D-75-82	Sampling Aggregates

Canadian Standards Association, National Standards of Canada (CAN3)

A23.1-2	Definitions
A23.1-3	Cement and Cementitious Materials
A23.1-5	Aggregates, 5.3 Normal Density Fine Aggregate 5.3.4 Soundness 5.4 Normal Density Coarse Aggregate 5.5 Petrographic Examination 5.6 Concrete-Making Properties 5.9 Aggregate Acceptance
A23.1-14	Mix Proportions, 14.3 Durability
A23.1	Appendix B Alkali-Aggregate Reaction Appendix B-B3 Tests for Alkali-Aggregate Reactivity
A23.2-9	A Soundness of Aggregate by Use of Magnesium Sulfate
A23.2-10	A Density of Aggregate
A23.2-13	A Flat and Elongated Particles in Coarse Aggregate
A23.2-14	A Alkali-Aggregate Reaction
A23.2-15	A Petrographic Examination of Aggregates for Concrete
A23.2	Appendix B Petrographic Analysis of Concrete Aggregate, Rev. 1986

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APPENDIX A

CONCRETE EXAMINATION REPORT

National Research Council Canada **Conseil national de recherches Canada**

Institute for Research in Construction
Institut de recherche en construction

CLIENT REPORT

for

Golder Associates
716 Water Street
St.John's
Newfoundland

Investigation of the cause of cracking of concrete in bridges in the Trinity Bay Region of Newfoundland

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Report date: 19 October 1987
Contract No. BR-5345
Reference: Application for test September 3, 1986
Section: Building Materials

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Canada

INVESTIGATION OF THE CAUSE OF CRACKING OF CONCRETE IN BRIDGES IN THE TRINITY BAY REGION OF NEWFOUNDLAND

SUMMARY:

Evidence of alkali-aggregate reactivity in the form of reaction rims around grains of reactive aggregate, cracks in aggregate particles and in the cement paste, debonding between aggregates and the surrounding cement paste and gel filling occasional air voids and cracks was observed in most of the cores. Examination of thin sections of the concrete showed that potentially reactive rocks of volcanic origin occur in all the concretes. The reactivity of these rocks is enhanced by the presence of a considerable quantity of secondary microcrystalline quartz which was observed in some of the samples, e.g. Cores TCH 008, TCH 010 and TCH 012. The aggregate in cores 2-013 and 2-070 contains 15% and 20% granite particles, respectively. The presence of granite particles is expected to reduce the reactivity of the rock; both these concretes show little evidence of alkali-aggregate reactivity. Not much evidence of reactivity was found in core 2-072; the aggregate in this concrete is composed mainly of devitrified volcanic glass with very little microcrystalline quartz; this could account for the lack of evidence of reactivity in this concrete.

INTRODUCTION:

Map cracking was observed in the concrete of several bridges along the Trans Canada Highway (TCH), between St.John's and Clarenville, during a visit to the area by the author in September 1986. Subsequently, cores were taken, by Golder Associates, from a number of bridges which showed cracking. The location of the cores is shown on the map, figure 1. The cores were sent to NRC in Ottawa for evaluation. This report covers the evaluation of the concrete from the cores.

SAMPLE PREPARATION AND EXAMINATION:

The concrete cores were sawn in half; the sawn surfaces of the slabs were then polished and thin sections were prepared from the slices. The polished slabs were examined with the aid of a stereoscopic binocular microscope. Thin sections were examined under a petrographic microscope.

RESULTS:

The composition of the aggregates in the concrete cores determined by examination of thin sections is summarized in Table 1. All the aggregates are composed of gravel which consists of about 80% volcanic rocks; i.e. andesite, altered tuff and devitrified glass. Granite, gabbro and diorite comprise about 10% of the rock particles, the remaining 10% being comprised of siltstone, slate and microcrystalline quartz (chert). Two samples, 2-013 and 2-070 contain 15% and 20% granitic rock fragments, respectively. Neither of these concrete cores showed much evidence of reactivity.

Potential reactivity of the rock types observed in thin sections:

1. **Devitrified Volcanic Glass:**

The devitrified volcanic glass appears, in thin section, as a slightly mottled rather featureless fine grained material, figure 2. Acid and intermediate volcanic glass is generally reactive with alkalis in concrete, however, the reactivity may be reduced by devitrification which involves the crystallization of the glass. In the present case, silicification occurred either during or subsequent to devitrification. Silicification involves the formation of microcrystalline quartz, a known reactive material. A significant amount of microcrystalline quartz was observed in the devitrified glass of the following samples: TCH-008 #2, TCH-010, TCH-012 and TCH-014. These samples, with the exception of TCH-012, showed considerable evidence of reactivity. In sample TCH-012, there is only moderate evidence for alkali-reactivity.

2. **Andesite:**

In thin section, andesites are seen to consist of feldspar phonocrysts in a matrix of fine grained feldspar laths, figure 3. The presence of microcrystalline quartz in the andesite indicates that it is potentially reactive. In core TCH-008, which shows much evidence of reactivity, the andesite contains up to 50% microcrystalline quartz.

3. **Altered Tuff:**

The appearance of the tuff in thin section varies depending on the degree of alteration and silicification. Typically, it consists of a very fine grained matrix in which occur larger grains of quartz and iron oxide, figure 4. The presence of microcrystalline quartz in this rock indicates that it is also potentially reactive. The typical appearance of microcrystalline quartz in thin sections is shown in figure 5. Core TCH-010 contains up to 50% microcrystalline quartz in the tuff; most tuffs contain much less. This core shows considerable evidence of reactivity.

4. **Siltstone & Slate:**

These rocks contain microcrystalline material including quartz and are hence potentially reactive. However, as they comprise only a small percentage of the aggregate, they are unlikely to contribute significantly to its reactivity. Note most of these rocks belong to the slow-late expanding type of reactive aggregate(1) for which the pessimum amount is 100%

5. **Granite:**

Granite is usually a non-reactive rock except for instances where the quartz is highly strained. Evidence of significant strain in quartz was not observed in this rock.

6. **Gabbro & Diorite:**

These rocks are generally non-reactive.

SUMMARY:

The volcanic rocks which form about 80% of the aggregates in the concrete cores are mostly highly silicified and contain a considerable amount of microcrystalline quartz which is a reactive material. For this reason, it is expected that concrete made with these aggregates should show evidence of alkali-aggregate reactivity.

RESULTS OF EXAMINATION OF POLISHED CONCRETE CORES:

TCH-008.

Both fine and coarse aggregate are of the same composition. The coarse aggregate particles are of a greenish to reddish brown color. About 75% of the aggregate is of volcanic origin, viz, andesite, tuff or devitrified glass. A small percentage of quartz and feldspar occurs in the fine aggregate. Reaction rims are rare on the larger aggregate particles but are common on the smaller sized ones. A typical particle with a reaction rim is shown in figure 6a which also shows open cracks partially filled with gel. Many of the pale green colored particles are extensively cracked; typically these cracks are open, figure 6b. Some air voids are filled with silica gel, a product of the alkali-silica reaction, figure 7. Other evidence of reactivity is the occurrence of debonding between the aggregate particles and the surrounding cement paste and the filling of the debonded area with silica gel, figure 8. Cracks were also observed running through both coarse aggregate particles and the mortar phase, this is also typical of concrete exhibiting alkali-aggregate reaction.

The concrete in this core shows considerable evidence of deterioration due to alkali-aggregate reaction. No evidence of scaling, characteristic of frost damage was observed.

TCH-010.

The coarse aggregate particles are dominantly composed of a greenish volcanic rock. A few percent of brown aggregate particles also occur. Both coarse and fine aggregate appear to be of the same composition. The air voids are empty, however this is not necessarily an indication that alkali-aggregate reaction has not occurred, because in the case of the slow-late expanding aggregates, the air voids are rarely filled even when the concrete showns considerable cracking. Cracks running through both coarse aggregate and the mortar phase are fairly common in this concrete, as are reaction rims around coarse aggregate particles, figure 9. Some large aggregate particles have open cracks, some of which are gel filled such as were also seen in TCH-008, figure 10.

2-034.

The color of the coarse aggregate varies from olive green to greenish brown. Both fine and coarse aggregates are of similar composition. The air voids are all empty. There is less evidence of reaction in this concrete than in the two previously described. Only a few coarse aggregate particles are rimmed. Some debonding was observed along with some fine cracks in the mortar phase.

TCH-012.

This sample is similar to 2-034 except for the presence of some white grains in the coarse aggregate. The air content of this sample appears to be inadequate. All the air voids are empty. A few aggregate particles show cracking and/or rim formation and some debonding also occurs. This concrete shows less evidence of reactivity than TCH-008 or TCH-010.

TCH-014.

The aggregate in this concrete is broadly similar to that of the samples described above apart from the presence of one grain of gypsum. There is no evidence of distress in the concrete surrounding the gypsum particle. Some particles of pale green rock are badly cracked, these are similar to what is shown in figure 6b. Cracking is common in the coarse aggregate particles and in the mortar phase. Some greenish aggregate particles were observed to have developed wide, dark reaction rims, figure 11. This sample contains very little air and hence would not appear to have been air entrained.

2-013.

The aggregate used in this concrete looks broadly similar to that described in previous samples except that the size of the coarse particles is larger (70 to 90 mm long). There is little evidence of reactivity in this concrete. A few aggregate particles have narrow reaction rims. Occasional closed cracks were observed in the mortar and a minor amount of debonding was observed. Air voids are empty. This sample does not appear to have been air entrained as the air content determined according to the ASTM Method C457 is only 2.88%.

2-072.

The gravel aggregate in this concrete is dominated by medium greenish grey colored rocks with some reddish brown particles. Both coarse and fine aggregate are comprised of the same material. A few fine cracks were observed in the mortar phase. Very few grains have reaction rims. One grain was observed which showed cracking and some of the cracks are partially gel filled. Air voids are sporadically distributed in the concrete suggesting accidental air inclusion rather than air entrainment. In summary, there is little evidence of alkali-aggregate reaction in this concrete.

2-070.

A gravel aggregate, similar to that found in the other cores, was used in this concrete. The size distribution of the aggregate is poor as there is a big gap between the 10 to 25 mm coarse aggregate and the fine aggregate with a mean grain size of less than 1 mm. The fine aggregate in this concrete contains more quartz grains than was observed in the concrete of the other cores. The coarse aggregate is dominantly of a greyish green color with some reddish brown particles. Most of the aggregate is of volcanic origin.

Some particles of granitic and basic rocks which are usually non-reactive were observed in this aggregate. One particle was observed with a weakly developed reaction rim. A few cracks were observed in the concrete; some contained a small amount of gel. No gel was observed in the air voids. This concrete appears to have been air entrained as it contains 6.34% of air voids. There is little evidence of alkali-reactivity in this sample despite the fact that it contains 45% andesite in the aggregate. The lack of significant evidence of reactivity in this concrete may be due, in part at least, to the presence of quartz grains in the fine aggregate and to the occurrence of 20% granite in the coarse aggregate.

CONCLUSIONS:

Petrographic examination of the concrete from the cores showed that similar aggregate, consisting largely of volcanic rocks, was used in all the samples. Evidence for alkali-aggregate reactivity varied from strong to weak in different samples, Table 1. The variation in reactivity as indicated by examination of the polished cores may possibly be correlated with the amount of microcrystalline quartz in the volcanic rocks and with the percentage of granite and other non-reactive material in the aggregates. The air content of many of the cores is inadequate but no evidence of frost damage to the concrete was found.

ADDENDUM:

The origin of the gravel that was used in the concrete from the bridges which were examined by the author in the Fall of 1986 was not known at that time. A sample of gravel from a beach a few hundred metres north of the jetty at Come-by-Chance was collected and made into a concrete prism which was then tested according to the accelerated concrete prism method as specified in the 1986 supplement to the CSA Standards CAN-A23.1-M77 and CAN3-A23.2-M77. The result of this test is shown in figure 12. It is concluded that this aggregate is reactive as the expansion will exceed the 0.04% limit at one year. A few pebbles were left over after the concrete had been made; a thin section was made from these. Examination of the thin section showed that the aggregate particles were broadly similar in composition to those described in this report. The similarity of the rocks in the gravel from the beach at Come-by-Chance to those observed in the concrete cores, described in this report, tends to support the evidence of reactivity observed in the polished cores. However, as only a few pebbles were examined in the thin section of the beach gravel there is no certainty that it is identical to that found in the concrete cores. An attempt should be made to determine the source of the gravels used in the concrete of the bridges and, if successful, the gravels should be tested using the accelerated concrete prism method A23.2-14A.

Note: The alkali content of the cement used in making the bridges is unknown, however even if it were moderately low, e.g. 0.8%, the addition of deicing salts would likely enhance the alkali level sufficiently to cause deleterious expansion and deterioration of the concrete.

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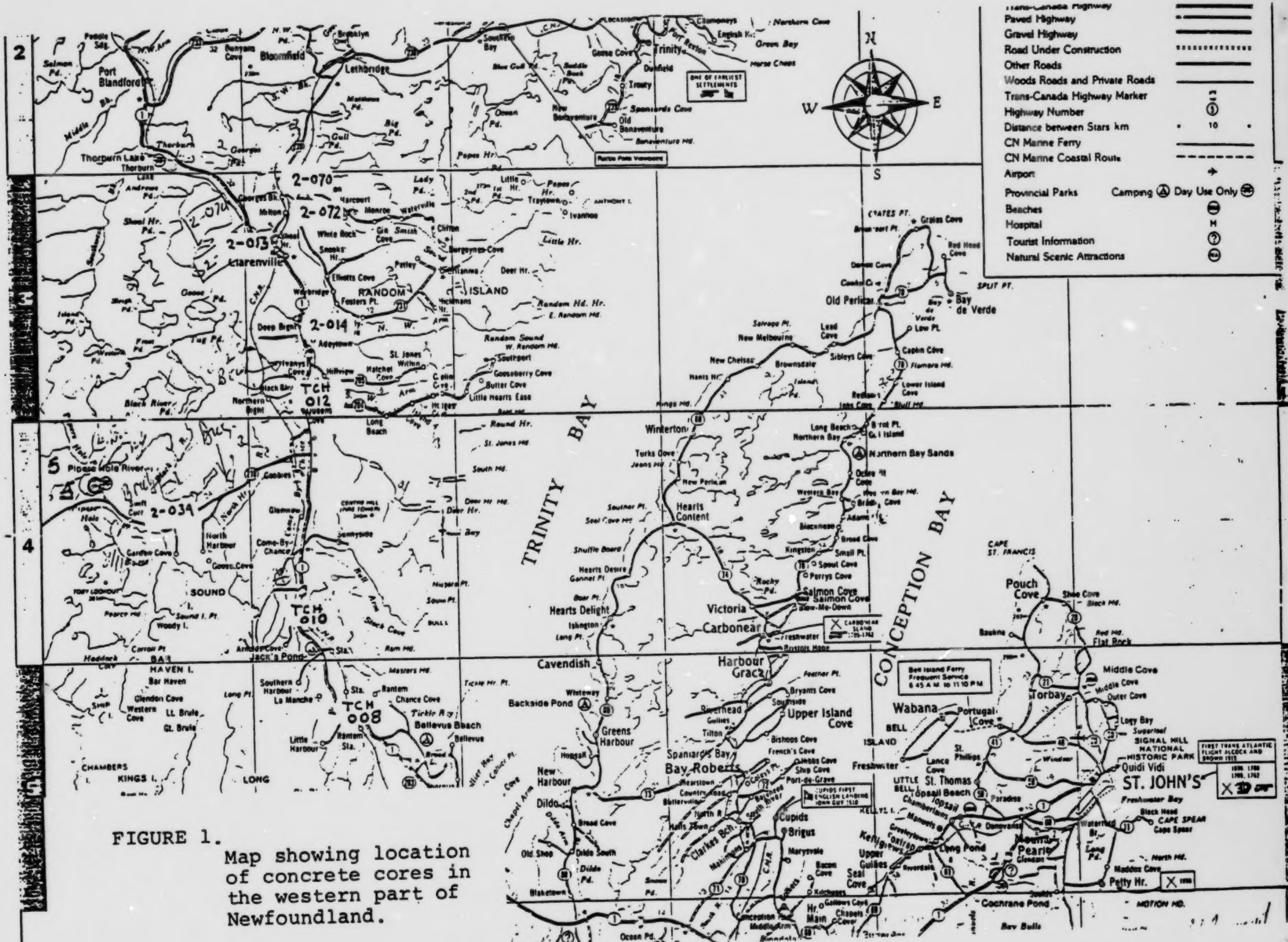
2-070
2-072
2-013
2-014
TCH 012
TCH 010
TCH 008
2-039
TRINITY BAY
CONCEPTION BAY
Clarenville
Port Blandford
Bloomfield
Lethbridge
Trinity
RANDOM ISLAND
Winterton
Hearts Content
Hearts Delight
Cavendish
Victoria
Carbonear
Harbour Grace
Bay Roberts
Wabana
BELL ISLAND
Torbay
ST. JOHN'S
Bay de Verde
Old Perlican
Jack's Pond
Bellevus Beach
Trans-Canada Highway
Paved Highway
Gravel Highway
Road Under Construction
Other Roads
Woods Roads and Private Roads
Trans-Canada Highway Marker
Highway Number
Distance between Stars km
CN Marine Ferry
CN Marine Coastal Route
Airport
Provincial Parks
Camping
Day Use Only
Beaches
Hospital
Tourist Information
Natural Scenic Attractions
N
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5

FIGURE 1. Map showing location of concrete cores in the western part of Newfoundland.

SAMPLE NO.	VOLCANIC GLASS	SILT STONE	ANDESITE	GRANITE	TUFF ALTERED	MICRO-QZ	SLATE	GABBRO/DIORIT	QZ/FELD	EVIDENCE OF AAR
	%	%	%	%	%	%	%	%	%	
TCH-008-1	10	5	45	5	15	2 to 3	5	2 to 3	5	S
TCH-008-2	5	-	40	5	40	1 to 2	-	2 to 3		
TCH-010-1	40	-	5	5	45	1 TO 2	5	1	2 TO 3	S
TCH-010-2	55	-	2	-	25 TO 30	1	1	5	2 TO 3	
TCH-012-1	15	-	-	10	60	2	3	3	5 TO 10	M
TCH-012-2	15	2	1	10	60	1	1	5	10	
2-013-1	-	1	20	5	55	3	5	1	10	W
2-013-2	5	-	45	15	10	2	5 TO 10		5	
TCH-014	-	1	20	5	55	3	5	1	10	S
2-070	5	-	45	20	-	5	5	10	10	W
2-072	65 TO 70	10	3	2	10	-	5	-	1	W
2-034-1	35	-	20	3	35	2	1	2	2	M
2-034-2	60	-	5	5	15	1	1	10	3	

LEGEND:
AAR - alkali-aggregate reactivity
S - strong evidence of reactivity
M - moderate evidence of reactivity
W - weak evidence of reactivity

TABLE 1. Mineralogical composition of aggregate in concrete cores.

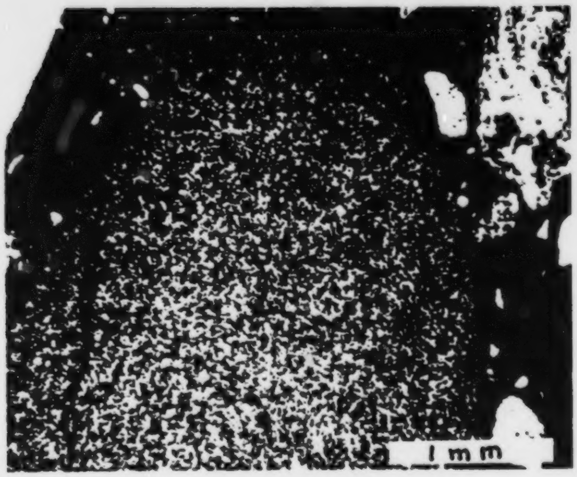


Fig. 2.

Optical micrograph of thin section of devitrified volcanic glass showing uniform fine texture.

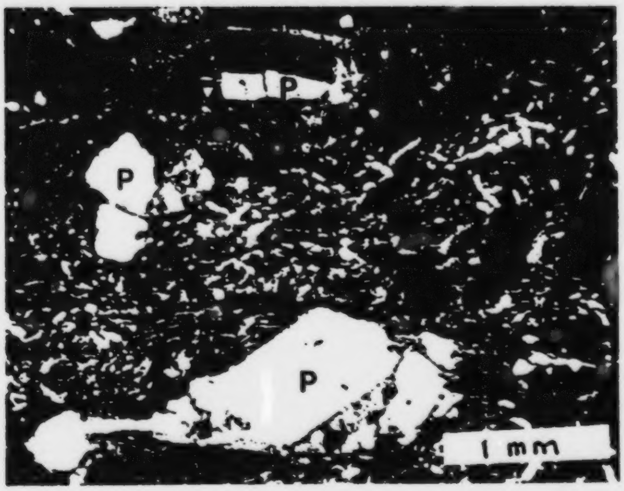


Fig. 3.

Optical micrograph of thin section of andesite showing large feldspar phenocrysts (P) in a matrix of micro-feldspar laths.

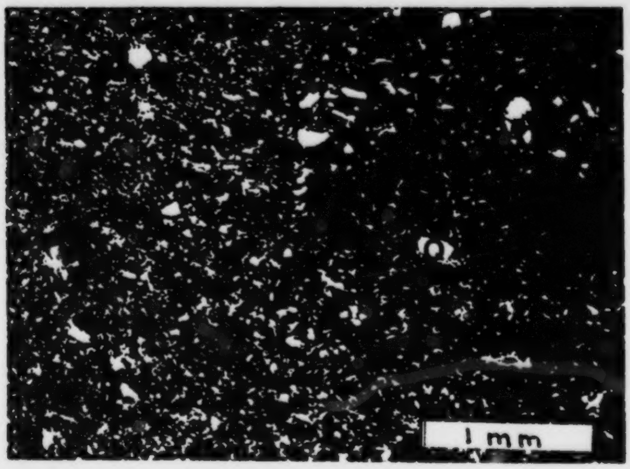


Fig 4.

Optical micrograph of thin section of altered tuff showing quartz grains (Q) in a fine matrix.

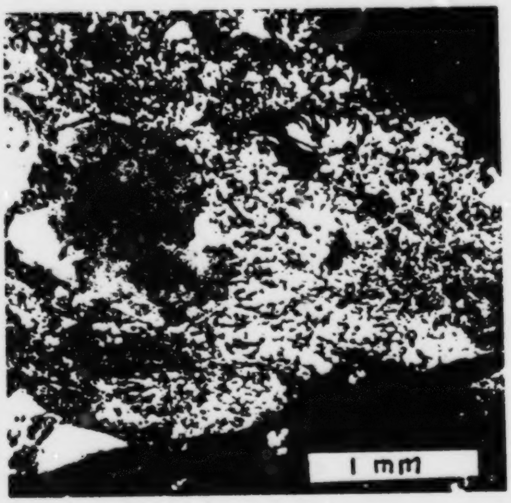


Fig. 5.

Optical micrograph of thin section of microcrystalline quartz showing typical mottled texture. The large crystal is quartz (Q)

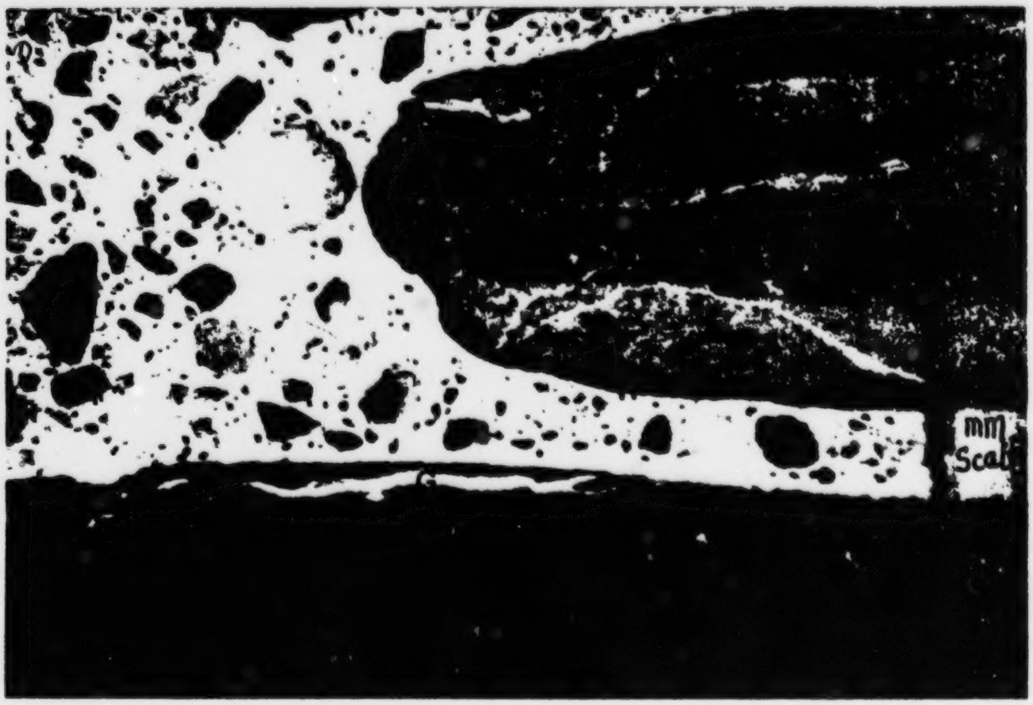


Fig. 6a.

Optical micrograph of polished surface of concrete core TCH-008 showing typical reaction rim (R) around, and cracking in, particle of reactive aggregate. Some gel (G) fills the crack.

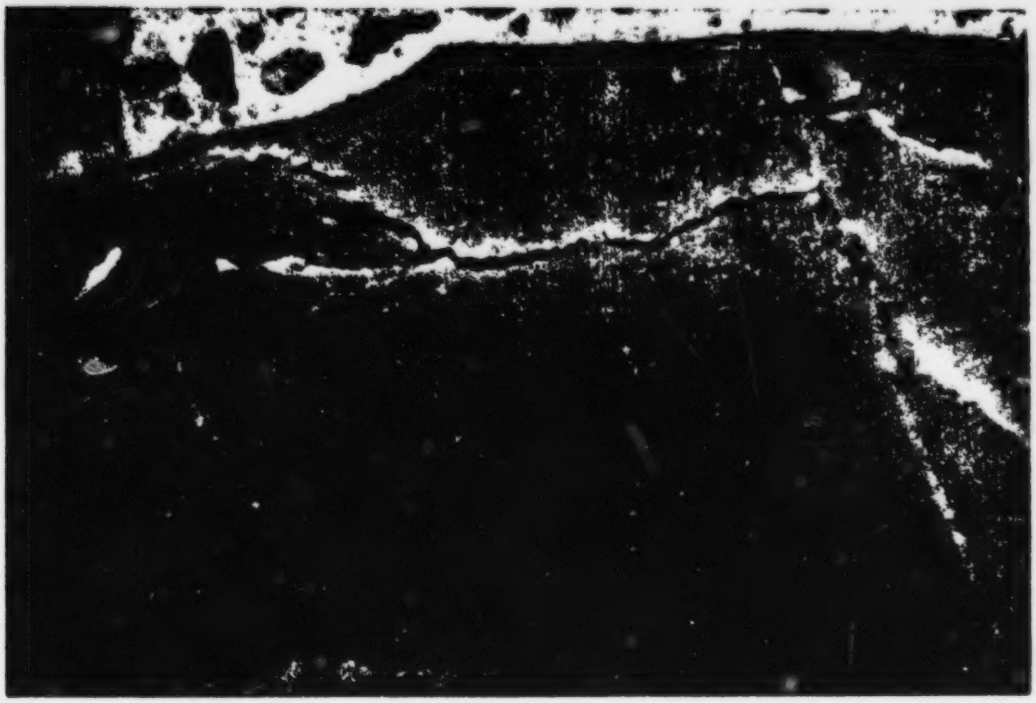


Fig. 6b.
Optical micrograph of polished surface of concrete core TCH-008 showing pale greeg particle with reaction rim and extensive open cracks.

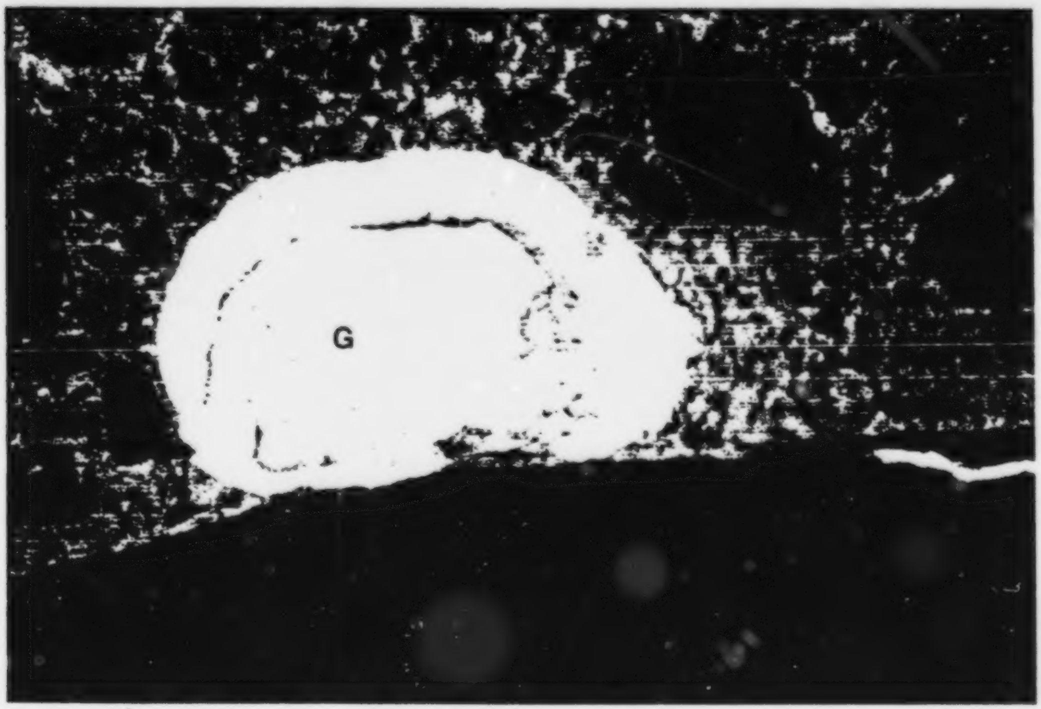


Fig. 7. Optical micrograph of polished surface of concrete core TCH-008 showing air void filled with gel (G).

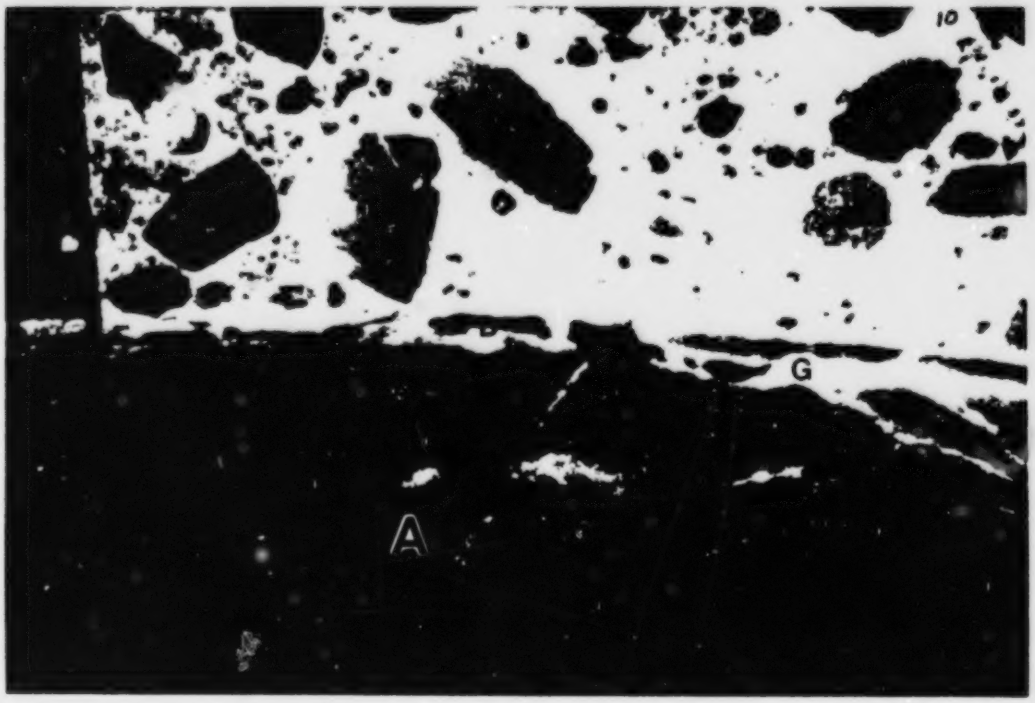


Fig. 8.

Optical micrograph of polished surface of concrete core TCH-008 showing debonding (D) between aggregate particle and surrounding paste. The gap between the arrgegate (A) and the paste is partially filled with gel (G).

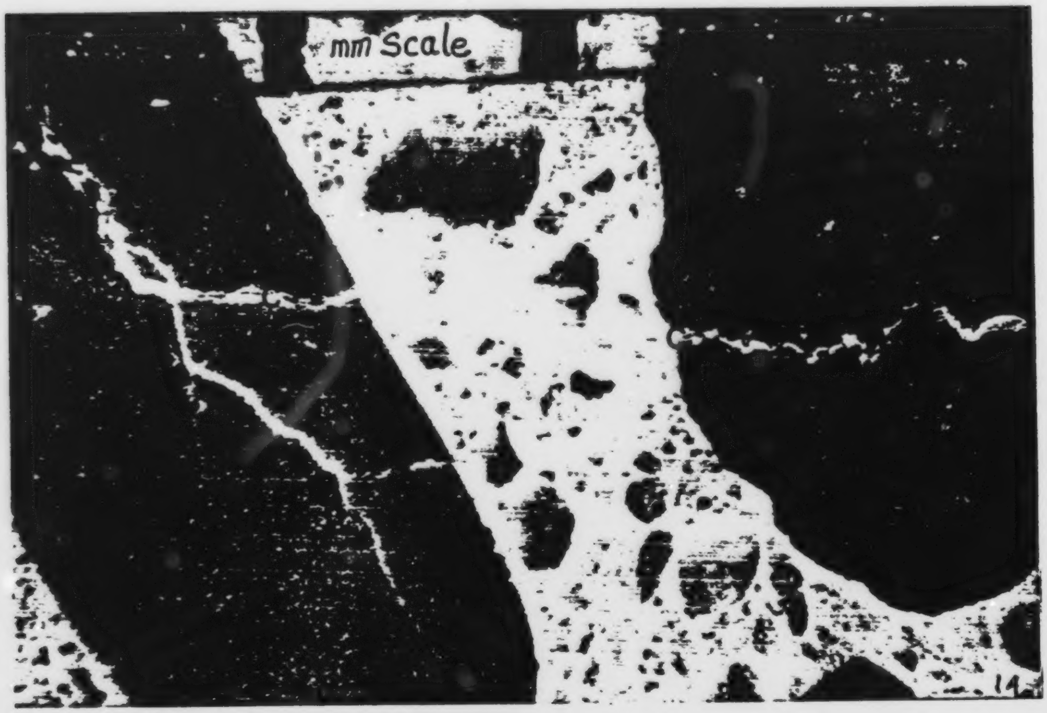


Fig.9.

Optical micrograph of polished surface of concrete core TCH-010, showing crack (C) partially filled with gel running through both aggregate particles and cement paste.

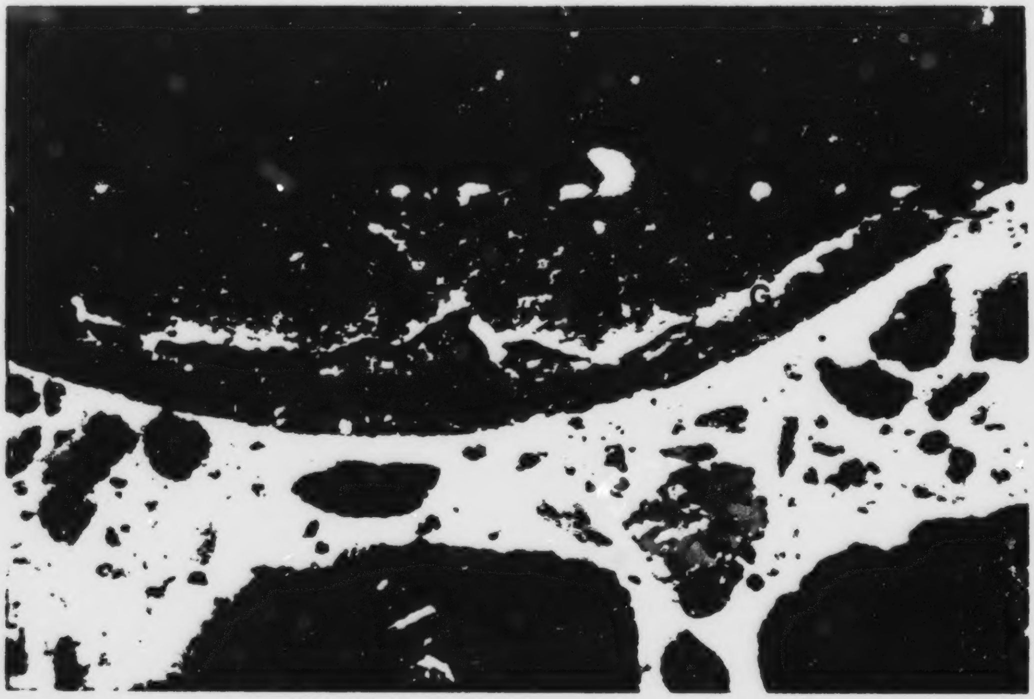


Fig. 10.
Optical micrograph of polished concrete core TCH-010 showing open crack partially filled with gel (G).

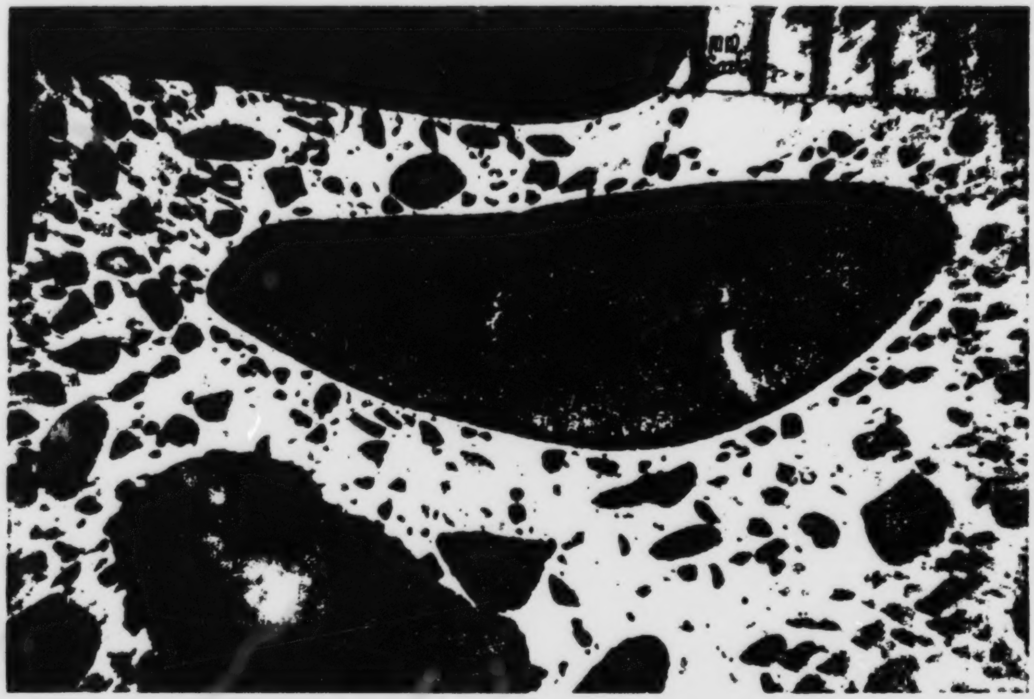


Fig 11.

Optical micrograph of polished surface of concrete core TCH-014 showing wide dark reaction rim around particle of reactive aggregate.

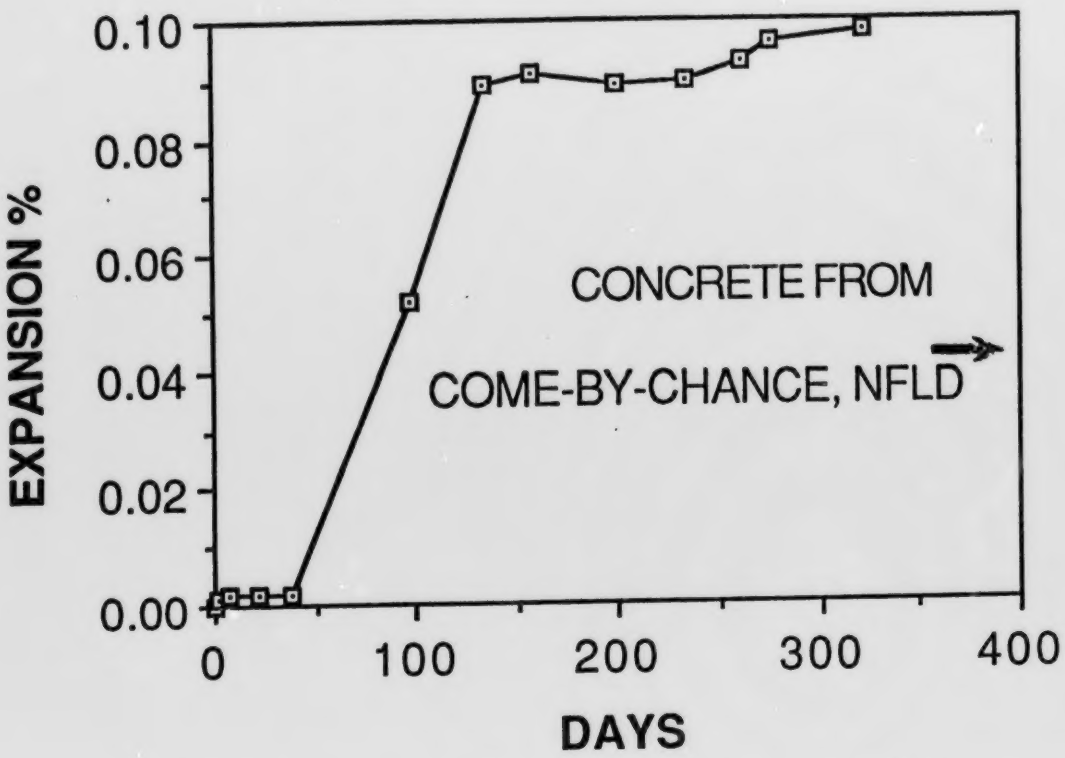


Fig. 12. Graph of expansion of concrete prism made with high alkali cement and gravel from a beach near the Come-by-Chance refinery. CSA expansion limit is shown with an arrow →

APPENDIX B

AGGREGATE TEST RESULTS

- Aggregate Summary Sheets and Categorization Charts
- Chemical Stability Test Results (ASTM C289)

AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3006 SOURCE: Swift Current TYPE: Sand

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	-	2.81	0.67	I
FINE	3.62	-	2.66	1.46	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Insufficient sample to determine abrasion loss for fine aggregate.

PETROGRAPHIC EXAMINATION

COARSE	CONSTITUENT
Major	Felsic volcanic/volcaniclastic
Intermed.	-
Minor	Granite
Trace	Rhyolite,Sandstone,Diorite,Quartz,Siltstone
FINE	CONSTITUENT
Major	Felsic volcanic/volcaniclastic
Intermed.	-
Minor	Quartz, Rhyolite
Trace	Granite, Sandstone, Diorite

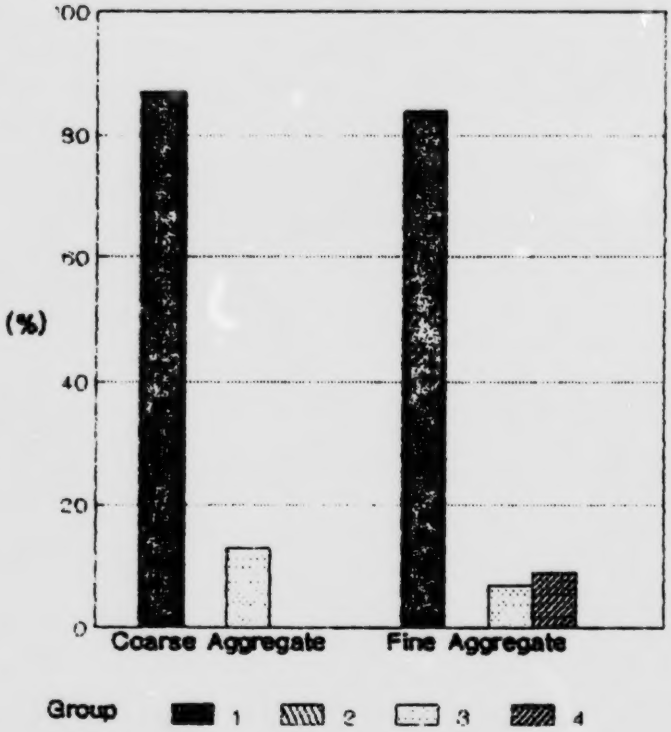
POTENTIAL REACTIVITY	
Group	%
1	87
2	-
3	13
Group	%
1	84
2	-
3	7
4	9

WEATHERING ASSESSMENT: Felsic volcanic/volcaniclastic particles (~5%) show slight weathering. Clay coatings are evident on some of these particles. Sample is generally slightly weathered.

ALKALI REACTIVITY POTENTIAL: High content of siliceous volcanogenic rocks (felsic volcanics). Potentially alkali silica reactive. Mortar bars cast.

Golder Associates

Sample 85-3006
Swift Current Site 6



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3008 SOURCE: Swift Current TYPE: Sandy Gravel

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.1	14.1	2.75	0.57	I
FINE	0.7	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Insufficient sample to determine abrasion loss for fine aggregate.

PETROGRAPHIC EXAMINATION

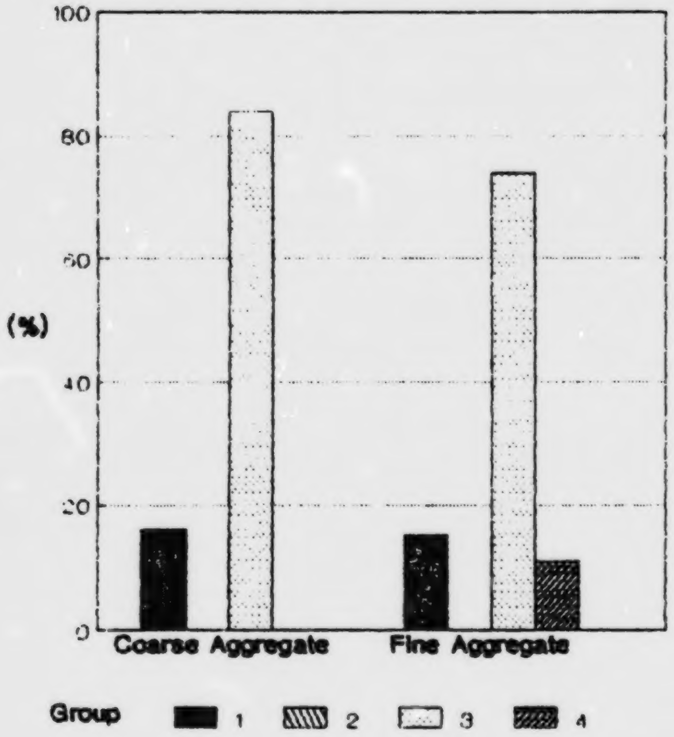
COARSE	CONSTITUENT
Major	Mafic volcanics
Intermed.	-
Minor	Granite
Trace	Sandstone, Rhyolite, Siltstone, Quartz
FINE	**CONSTITUENT**
Major	Mafic volcanics
Intermed.	-
Minor	Granite, Quartz
Trace	Sandstone, Diorite

POTENTIAL REACTIVITY	
Group	%
1	16
2	-
3	84
Group	**%**
1	15
2	-
3	74
4	11

WEATHERING ASSESSMENT: Mafic volcanic and granite fractions have approximately 5% clay coatings and are slightly weathered. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL:
High content of mafic volcanic rocks, low percentages of sandstone and siliceous volcanogenic rocks. Potentially non reactive. Mortar bars cast.

Sample 85-3008
Swift Current Site 9



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3017 SOURCE: Swift Current TYPE: Sand and Gravel

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.0	14.8	2.71	0.51	I
FINE	1.4	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious

COMMENTS: Insufficient sample to determine abrasion loss for fine aggregate.

PETROGRAPHIC EXAMINATION

COARSE	CONSTITUENT
Major	Mafic volcanic
Intermed.	-
Minor	Rhyolite, Granite
Trace	Sandstone, Siltstone, Diorite, Quartz
FINE	**CONSTITUENT**
Major	-
Intermed.	Mafic volcanic
Minor	Quartz, Granite, Rhyolite
Trace	Sandstone, Diorite

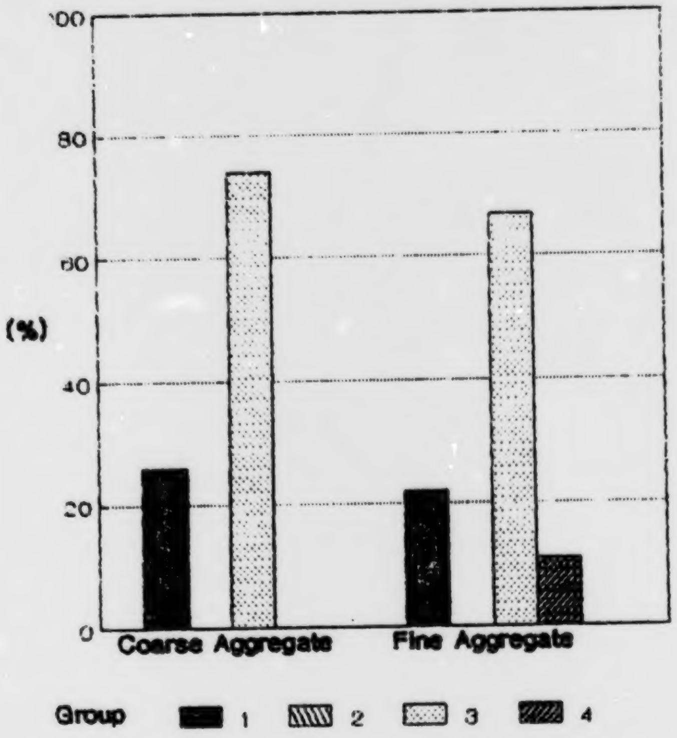
POTENTIAL REACTIVITY	
Group	%
1	26
2	-
3	74
Group	%
1	22
2	-
3	67
4	11

WEATHERING ASSESSMENT: The mafic volcanic, granite and diorite fractions contain minor amounts (<5% total) of slightly weathered particles. A small percentage of mederately weathered schist fragments were also observed. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: High content of mafic volcanic fragments. The fine fractions contain minor amounts of quartz, derived from granite and rhyolite fragments. Potential alkali-silica reaction. Mortar bars were cast.

7

Sample 85-3017
Swift Current Site 16



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3032 SOURCE: Swift Current TYPE: Sandy Gravel

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	-	2.74	0.75	I
FINE	2.8	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Insufficient sample to determine abrasion and soundness loss.

PETROGRAPHIC EXAMINATION

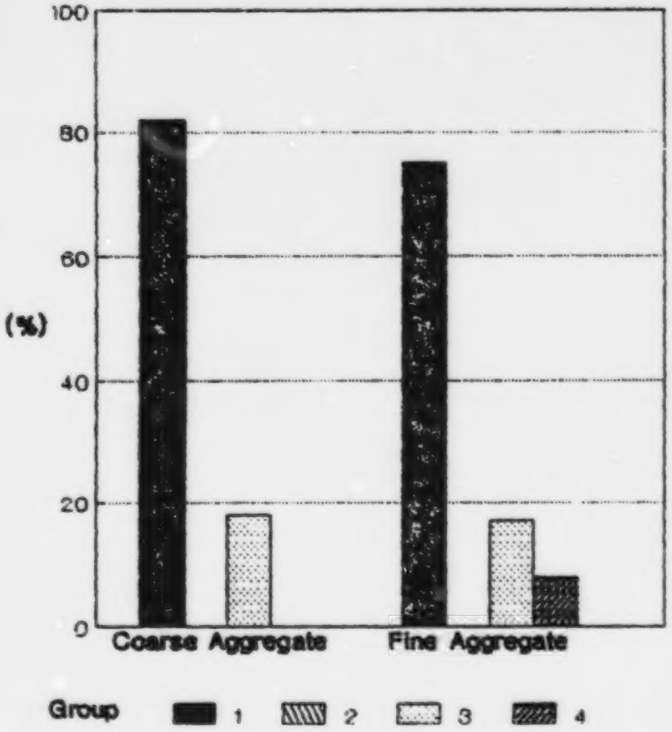
COARSE	CONSTITUENT
Major	Felsic volcanics
Intermed.	-
Minor	-
Trace	Granite,Rhyolite,Sandstone,Diorite,Quartz
FINE	**CONSTITUENT**
Major	Felsic volcanics
Intermed.	-
Minor	Granite
Trace	Quartz, Rhyolite, Sandstone, Diorite

POTENTIAL REACTIVITY	
Group	%
1	82
2	-
3	18
Group	%
1	75
2	-
3	17
4	8

WEATHERING ASSESSMENT: Approximately 5% of the felsic volcanic, granite and sandstone particles have slightly weathered surfaces. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: High content of siliceous volcanogenic particles (felsic volcanics) imply a potential for the alkali silica reaction. Mortar bars were cast.

Sample 85-3032
Swift Current Site 30



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3047 SOURCE: Swift Current TYPE: Sandy Gravel

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	15.2	2.72	0.57	I
FINE	0.5	-	2.67	1.94	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: High absorption values for fine aggregate.

PETROGRAPHIC EXAMINATION

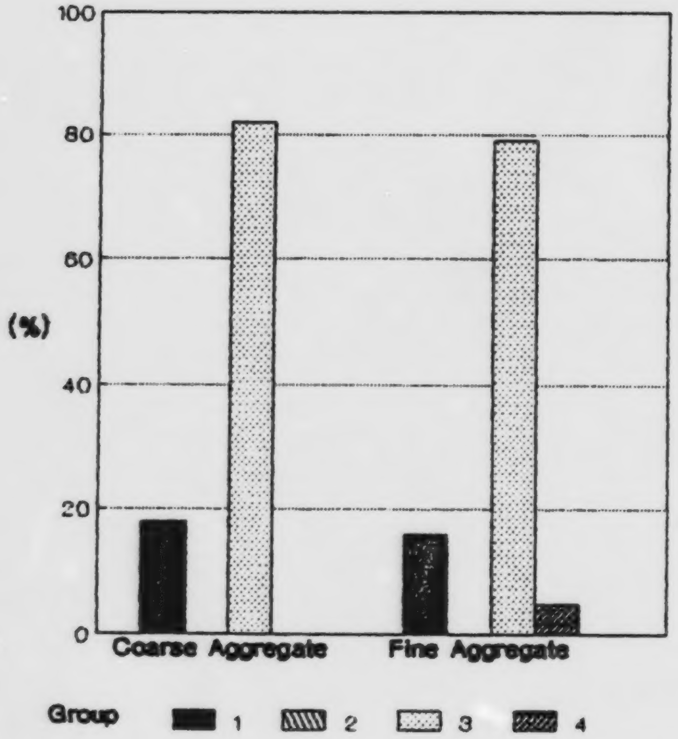
COARSE	CONSTITUENT
Major	-
Intermed.	-
Minor	Granite, Mafic volcanics, Diorite, Rhyolite
Trace	Basalt, Sandstone, Gabbro, Siltstone
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	Mafic volcanics, Granite, Diorite, Rhyolite
Trace	Gabbro, Basalt, Quartz

POTENTIAL REACTIVITY	
Group	%
1	25
2	-
3	75
Group	%
1	22
2	-
3	73
4	5

WEATHERING ASSESSMENT: Approximately 5% of the mafic volcanic, granite and rhyolite particles demonstrate slight degrees of weathering. Seritization of feldspars in granite fragments was observed. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: High content of mafic volcanic particles implies a low probability of expansive reactions. This sample is potentially non reactive. Mortar bars and prisms were cast.

Sample 85-3047
Swift Current Site 42



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3050 SOURCE: Swift Current TYPE: Sand

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	17.4	2.70	0.68	I
FINE	1.5	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious

COMMENTS: Insufficient material for soundness loss testing on the coarse fraction.

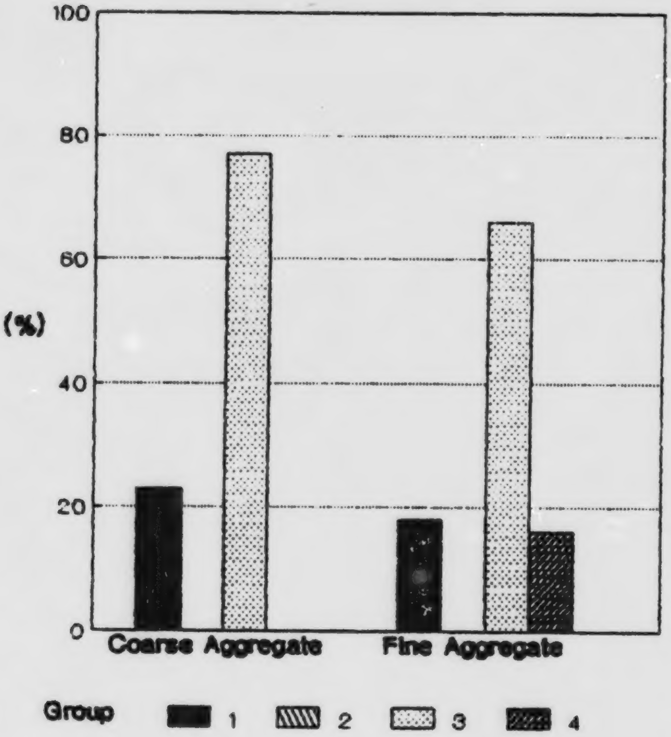
PETROGRAPHIC EXAMINATION

COARSE	CONSTITUENT	POTENTIAL REACTIVITY	
Major	Volcaniclastic	Group	%
Intermed.	-	1	23
Minor	Rhyolite, Granite	2	-
Trace	Basalt, Diorite, Sandstone, Siltstone, Quartz	3	77
FINE	CONSTITUENT	Group	%
Major	-	1	18
Intermed.	-	2	-
Minor	Mafic volc., Granite, Quartz, Rhyolite, Diorite	3	66
Trace	Basalt, Sandstone, Siltstone, Schist	4	16

WEATHERING ASSESSMENT: Approximately 5% of the mafic volcanic, rhyolite and granite particles are slightly weathered. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: High content of mafic volcanic/volcaniclastic particles implies a low probability for expansive reactions. Fine aggregate has a minor quantity of granular quartz. Alkali silica reactions may occur. Mortar bars were cast.

Sample 85-3050
Swift Current Site 49



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3058 SOURCE: Swift Current TYPE: Sandy Gravel

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.2	12.9	2.75	0.60	I
FINE	1.4	-	2.53	5.57	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Extremly high absorption values for fine aggregate.

PETROGRAPHIC EXAMINATION

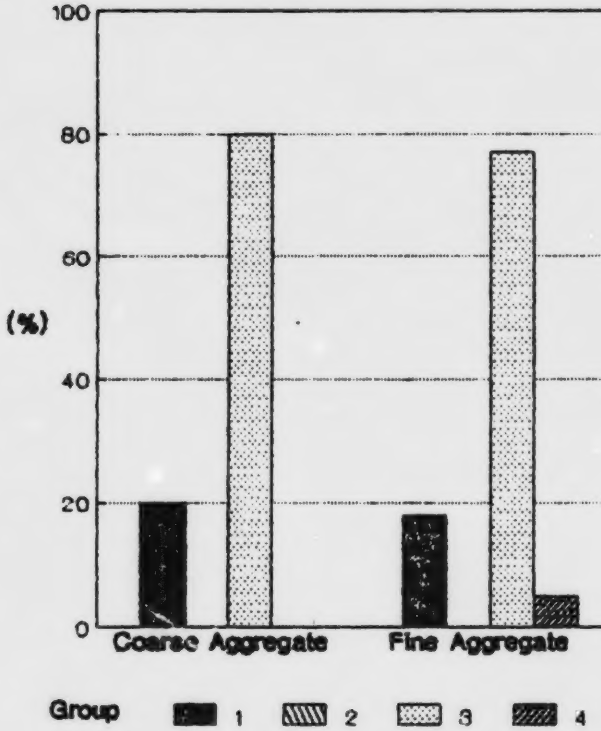
COARSE	CONSTITUENT
Major	Mafic volcanic
Intermed.	-
Minor	Granite, Sandstone, Rhyolite
Trace	Sandstone, Siltstone, Diorite
FINE	CONSTITUENT
Major	Mafic volcanic
Intermed.	-
Minor	Granite, Rhyolite
Trace	Quartz, Sandstone, Diorite

POTENTIAL REACTIVITY	
Group	%
1	20
2	-
3	80
Group	%
1	18
2	-
3	77
4	5

WEATHERING ASSESSMENT: Approximately 10% of the mafic volcanic, granite and sandstone particles are slightly weathered. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: The high content of mafic volcanic particles implies a low probability of expansive reactions. Sample is potentially non-reactive. Mortar bars were cast.

Sample 85-3058
Swift Current Site 55



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3065 SOURCE: Pipers Hole TYPE: Sandy Gravel

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.0	15.4	2.76	0.55	I
FINE	0.94	-	2.66	2.10	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: High absorption values for the fine aggregate.

PETROGRAPHIC EXAMINATION

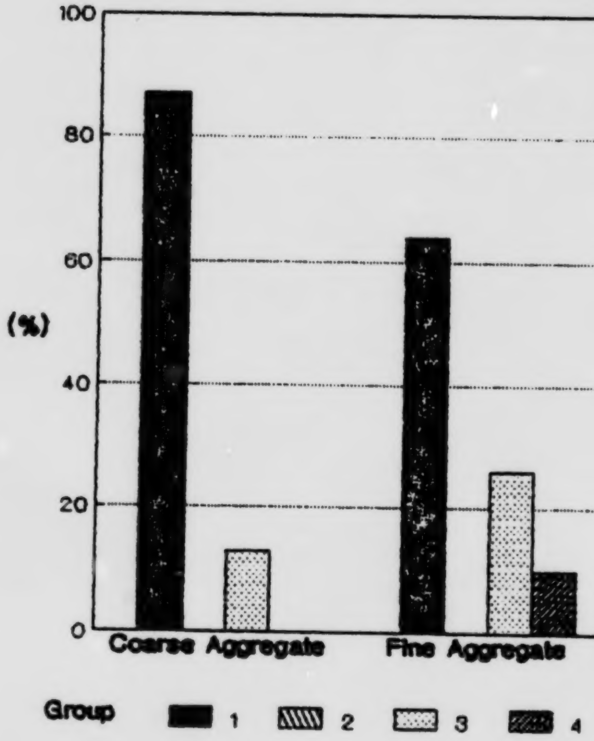
COARSE	CONSTITUENT
Major	Felsic tuff/volcaniclastic
Intermed.	-
Minor	Rhyolite, Sandstone, Granite
Trace	Siltstone, Diorite, Schist, Quartz
FINE	**CONSTITUENT**
Major	-
Intermed.	Felsic tuff/volcaniclastic
Minor	Granite
Trace	Quartz,Rhyolite,Sandstone,Siltstone,Diorite

POTENTIAL REACTIVITY	
Group	%
1	87
2	-
3	13
Group	%
1	64
2	-
3	25
4	10

WEATHERING ASSESSMENT: Approximately 15% of the felsic tuff, sandstone and granitic fragments show slight weathering. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: Major amounts of felsic tuff, with minor rhyolite particles imply a probable alkali silica reaction. Mortar bars were cast.

Sample 85-3065
Swift Current Site 63



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3066 SOURCE: Pipers Hole TYPE: Gravel

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	-	2.71	0.77	I
FINE	0.6	-	2.65	1.05	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Insufficient sample for abrasion loss testing.

PETROGRAPHIC EXAMINATION

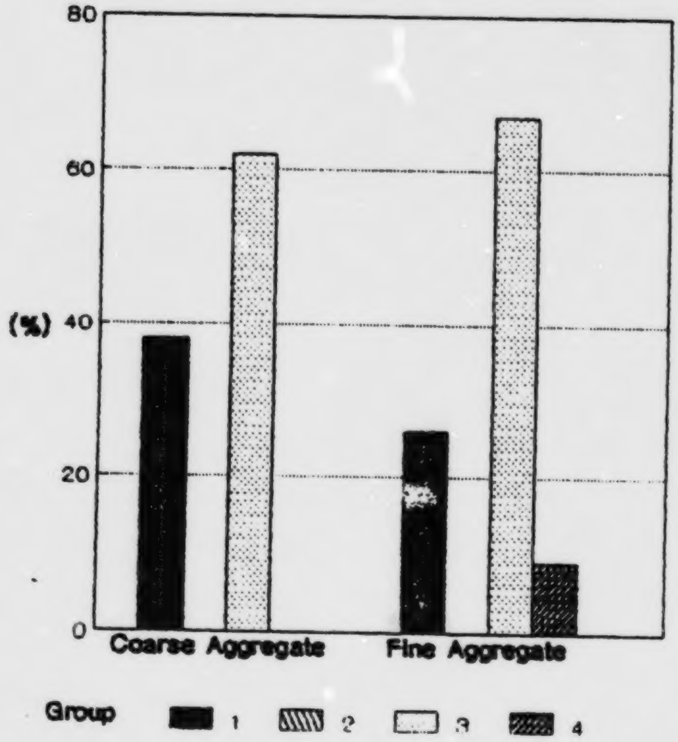
COARSE	CONSTITUENT
Major	-
Intermed.	Mafic volcanic
Minor	Felsic tuff, Rhyolite, Granite
Trace	Schist, Gabbro, Clay-rich fragments
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	Mafic volcanic, Granite, Kspar
Trace	Felsic tuff, Rhyolite, Qtz, Diorite, Gabbro

POTENTIAL REACTIVITY	
Group	%
1	38
2	-
3	62
Group	%
1	26
2	-
3	67
4	9

WEATHERING ASSESSMENT: Sample contains 2-4% of slightly weathered felsic tuff and granite. Schist and clay-rich fragments comprise 8-9% of the coarse fractions. These particles are moderately to highly weathered and are potentially deleterious.

ALKALI REACTIVITY POTENTIAL: Minor proportions (10-20%) of felsic tuff, combined with rhyolite, schist and quartz particles, results in a moderate (20-40%) percentage of potentially alkali silica reactive components. Mortar bars were cast.

Sample 85-3066
Swift Current Site 64



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-3161 SOURCE: Black River Pt. TYPE: Sandy Gravel

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	-	2.76	0.45	I
FINE	0.9	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Insufficient sample for abrasion loss and soundness testing.

PETROGRAPHIC EXAMINATION

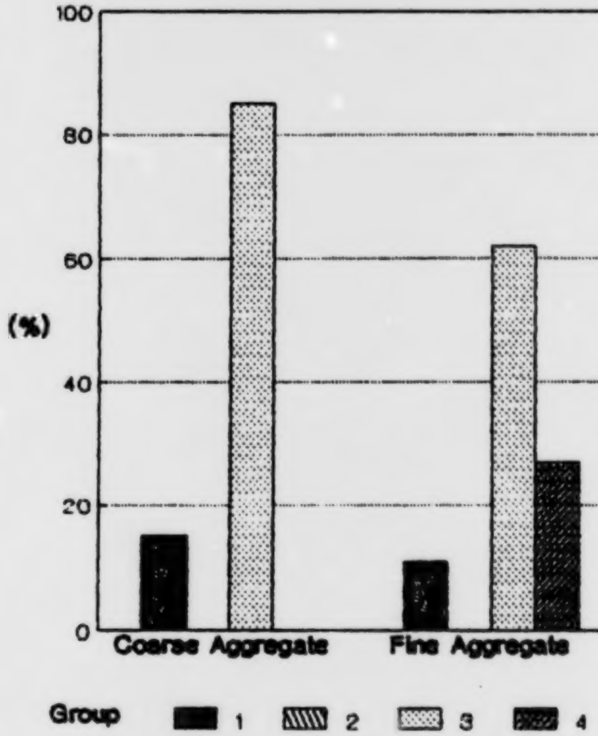
COARSE	CONSTITUENT
Major	Granite
Intermed.	-
Minor	Basalt
Trace	Mafic vol, Rhyo, Dior, Sandst, Siltst, Schist
FINE	CONSTITUENT
Major	-
Intermed.	-
Minor	Quartz, Granite, Basalt, Diorite
Trace	Rhyolite, Mafic volcanic, Sandstone, Siltstone

POTENTIAL REACTIVITY	
Group	%
1	15
2	-
3	85
Group	%
1	11
2	-
3	62
4	27

WEATHERING ASSESSMENT: Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: Sample contains high proportions of granitic material. Petrographic analysis of these fragments reveals quartz grains (ca~25%) to be unstrained. The high granular quartz content in the finer fractions may result in alkali silica reactions Mortar bars were cast.

Sample 85-3161
Black River Point Site 96



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-6200 SOURCE: Adam's Head TYPE: Coastal Rock

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.1	-	2.69	0.28	D
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Sample consists of cobble size fragments. Quick chemical results indicate sample is deleterious.

PETROGRAPHIC EXAMINATION

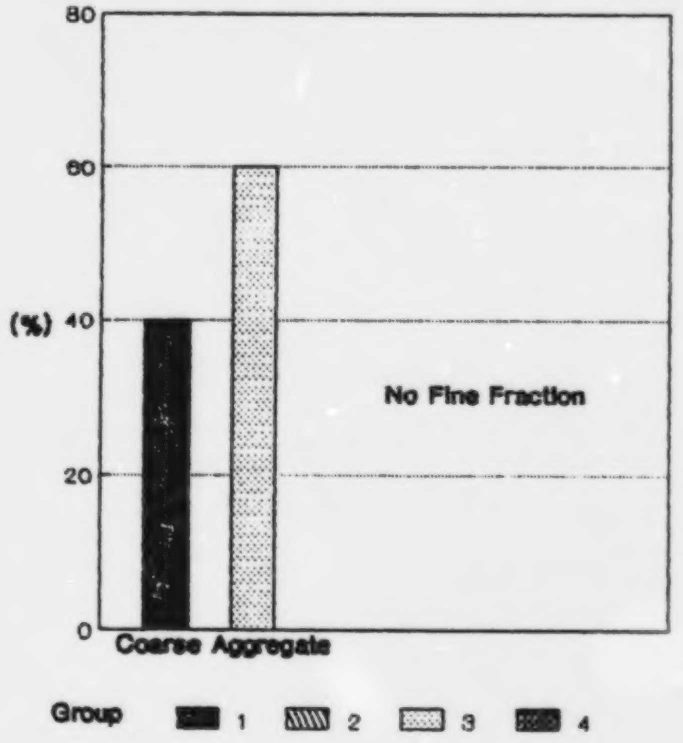
COARSE	CONSTITUENT
Major	Diabase
Intermed.	Sandstone (arkose)
Minor	-
Trace	-
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	40
2	-
3	60
Group	**%**
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Sample was obtained from a coastal exposure, and is generally unweathered.

ALKALI REACTIVITY POTENTIAL: Arkose contains approximately 25% quartz, 80% of which is unstrained. This sample may be subject to slow-late alkali silicate reactions. Mortar bars and prisms were cast.

Sample 85-6200
Adams Head Site 167



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-6213 SOURCE: Adam's Head TYPE: Coastal Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.3	-	2.70	0.23	D
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious

COMMENTS: Sample consists of cobble size fragments. Quick chemical results indicate sample is deleterious.

PETROGRAPHIC EXAMINATION

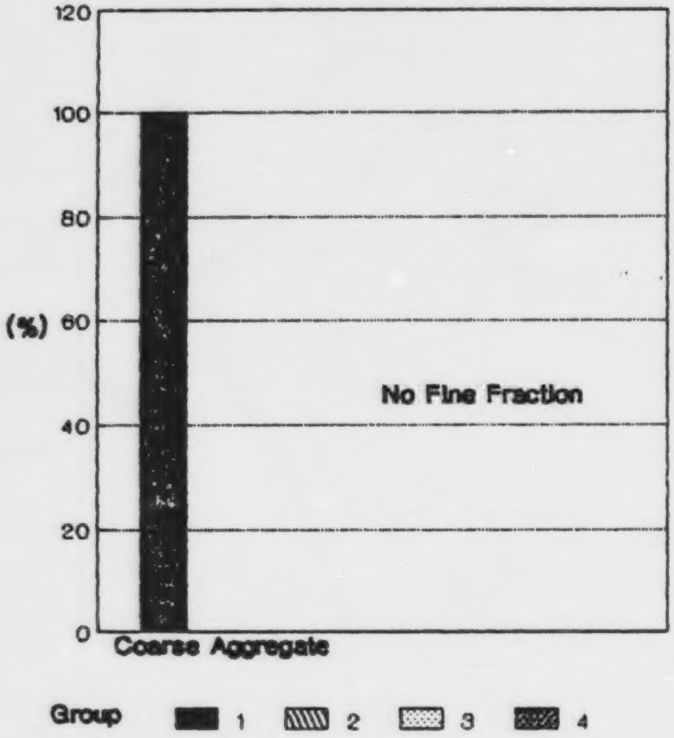
COARSE	CONSTITUENT
Major	Sandstone (arkose)
Intermed.	-
Minor	-
Trace	-
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	100
2	-
3	-
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Unweathered coastal rock.

ALKALI REACTIVITY POTENTIAL: Potential for slow-late reactions. Insufficient sample. Combined with 85 6214 to make prisms.

Sample 85-6213
Adams Head Site 180



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-6214 SOURCE: Adam's Head TYPE: Coastal Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.1	-	2.71	0.24	D
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Sample consists of cobble size fragments. Quick chemical results indicate sample is deleterious.

PETROGRAPHIC EXAMINATION

COARSE	CONSTITUENT
Major	Sandstone (arkose)
Intermed.	-
Minor	-
Trace	-
FINE	CONSTITUENT
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	100
2	-
3	-
Group	%
1	-
2	-
3	-
4	-

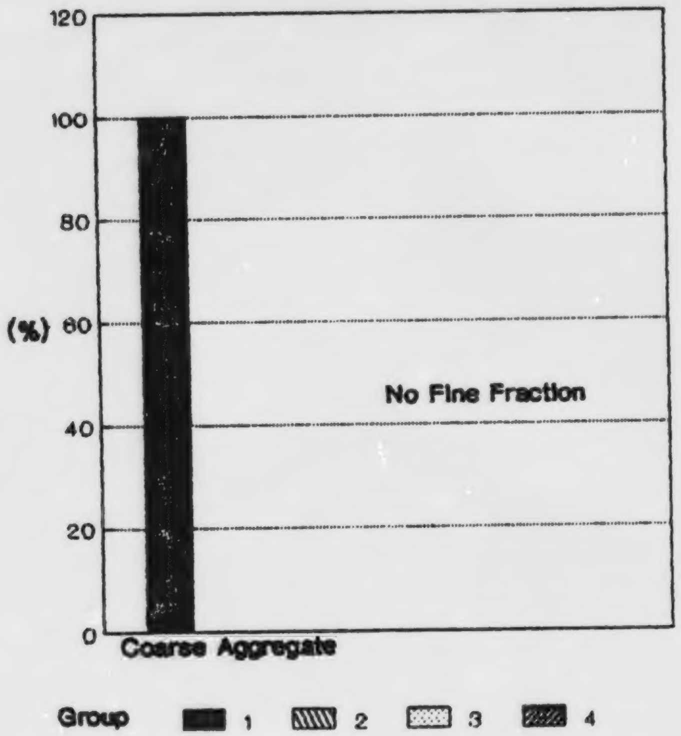
WEATHERING ASSESSMENT: Unweathered coastal rock.

ALKALI REACTIVITY POTENTIAL: Potential for slow late reactions. Insufficient sample. Mortar bars cast and the remainder combined with 85 6213 to make prisms.

Golder Associates

7

Sample 85-6214
Adams Head Site 181



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-6215 SOURCE: Adam's Head TYPE: Coastal Rock

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.3	-	2.68	0.23	D
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Sample consists of cobble sized fragments. Quick chemical results indicate sample is deleterious.

PETROGRAPHIC EXAMINATION

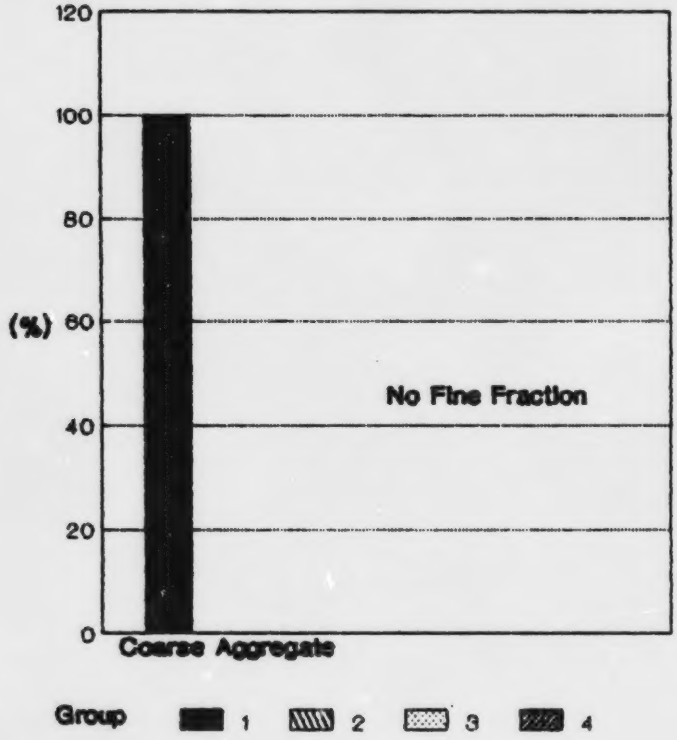
COARSE	CONSTITUENT
Major	Sandstone (arkose)
Intermed.	-
Minor	-
Trace	-
FINE	CONSTITUENT
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	100
2	-
3	-
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Unweathered coastal rock.

ALKALI REACTIVITY POTENTIAL: Potential for slow-late reactions. Insufficient sample. Combined with 85 6216 to make prisms.

Sample 85-6215
Adams Head Site 182



AGGREGATE SUMMARY SHEET

SAMPLE No.: 85-6216 SOURCE: Adam's Head TYPE: Coastal Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.0	-	2.69	0.28	D
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Sample consists of cobble sized fragments. Quick chemical results indicate sample is deleterious.

PETROGRAPHIC EXAMINATION

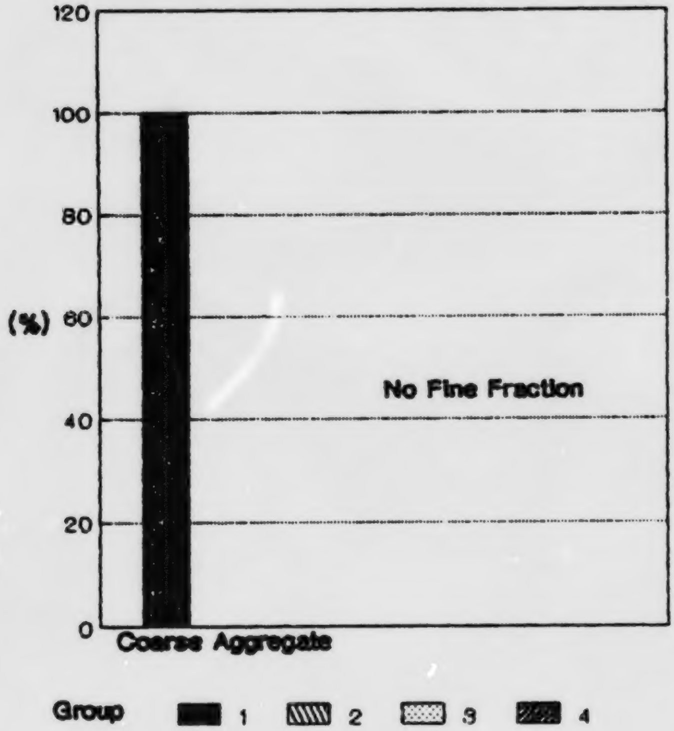
COARSE	CONSTITUENT
Major	Sandstone (arkose)
Intermed.	-
Minor	-
Trace	-
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	100
2	-
3	-
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Unweathered coastal rock.

ALKALI REACTIVITY POTENTIAL: Potential for slow-late reactions. Insufficient sample. Combined with 85 6215 to make prisms.

Sample 85-6216
Adams Head Site 183



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6001 SOURCE: Holyrood TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.3	18.6	2.62	0.35	I
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Only coarse aggregate was provided.

PETROGRAPHIC EXAMINATION

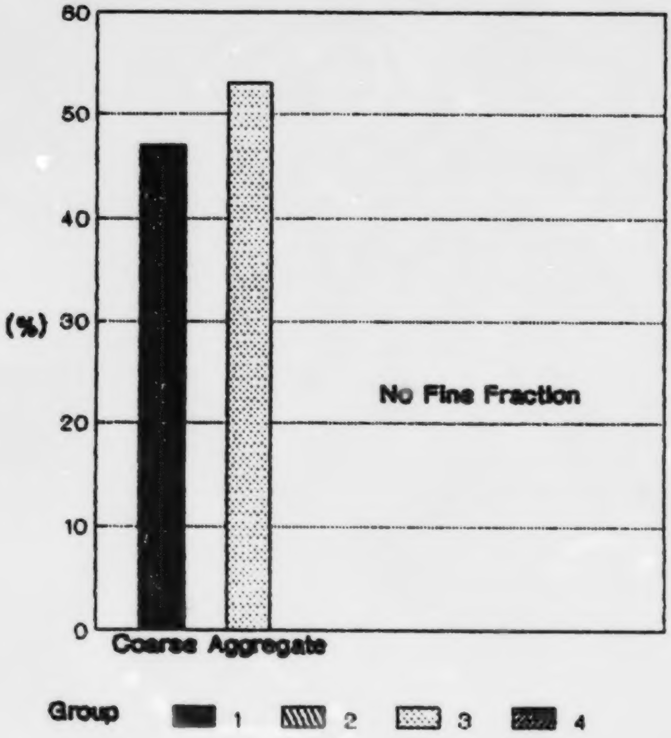
COARSE	CONSTITUENT
Major	Granite
Intermed.	-
Minor	Sandstone, Siltstone
Trace	-
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	47
2	-
3	53
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Small amount (<5%) of the granite and sandstone fragments are slightly weathered. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL:
Petrographic analysis of granite particles suggests approximately 70% of the quartz (ca 40%) is unstrained. The remainder shows weak undulatory extinction. This strained quartz combined with minor contents of sandstone suggests a potential for slow-late alkali silicate reactions. Mortar bars and prisms were cast.

Sample 86-6001
Holyrood



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6002 SOURCE: Port aux Basque TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.6	21.0	2.73	0.37	I
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Only coarse aggregate provided.

PETROGRAPHIC EXAMINATION

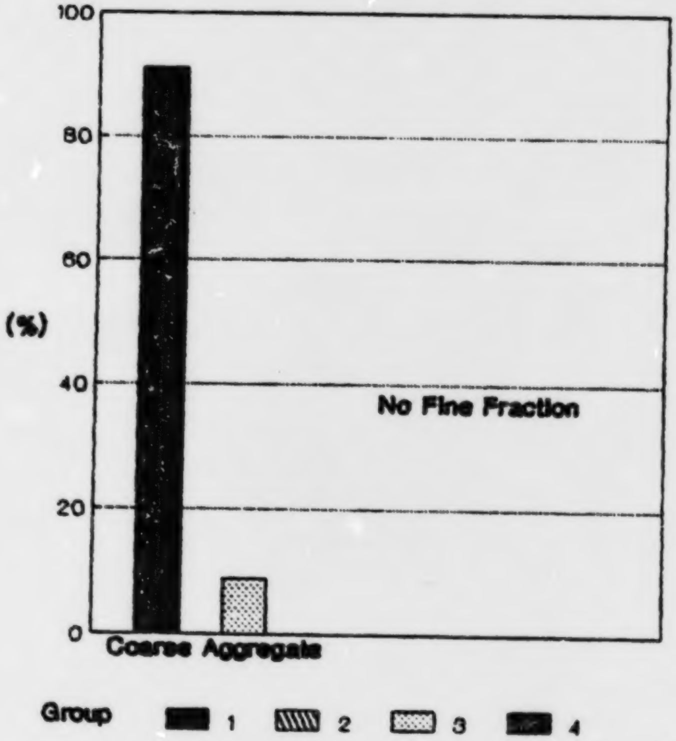
COARSE	CONSTITUENT
Major	Granodiorite
Intermed.	-
Minor	Granite, Sandstone
Trace	Diorite, Gabbro, Schist, Quartz
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	19
2	-
3	81
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Approximately 1-2% of the granodiorite, granite and sandstone particles exhibit surficial weathering. The sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: Petrographic analysis of granodiorite particles indicates quartz (ca 20%) is both strained (~70%) and recrystallized. This combined with minor contents of granite and sandstone suggest the possibility for slow-late alkali silicate reactions. Mortar bars and prisms were cast.

Sample 86-6002
Port aux Basques



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6003 SOURCE: Stephenville TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	-	2.78	0.62	I
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Insufficient sample to determine soundness and abrasion losses. Only coarse aggregate available.

PETROGRAPHIC EXAMINATION

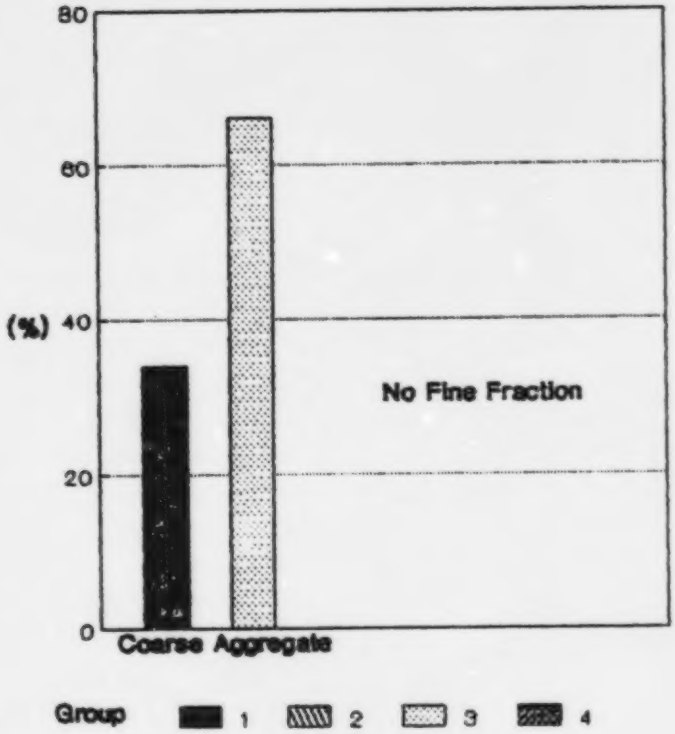
COARSE	CONSTITUENT
Major	-
Intermed.	Diorite
Minor	Quartzite, Granodiorite
Trace	Granite, Rhyolite, Schist
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	34
2	-
3	66
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Low percentages of the granite and quartzite fractions have weathered surfaces. The sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: The moderate content of quartzite particles implies a potential for alkali silica reactions. Mortar bars were cast.

Sample 86-6003
Stephenville



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6004 SOURCE: St. Anthony TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.9	21.1	2.72	0.34	I
FINE	0.2	-	2.54	3.78	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious

COMMENTS: Abrasion loss C535 (coarse) = 24.3% High absorption values for fine aggregate.

PETROGRAPHIC EXAMINATION

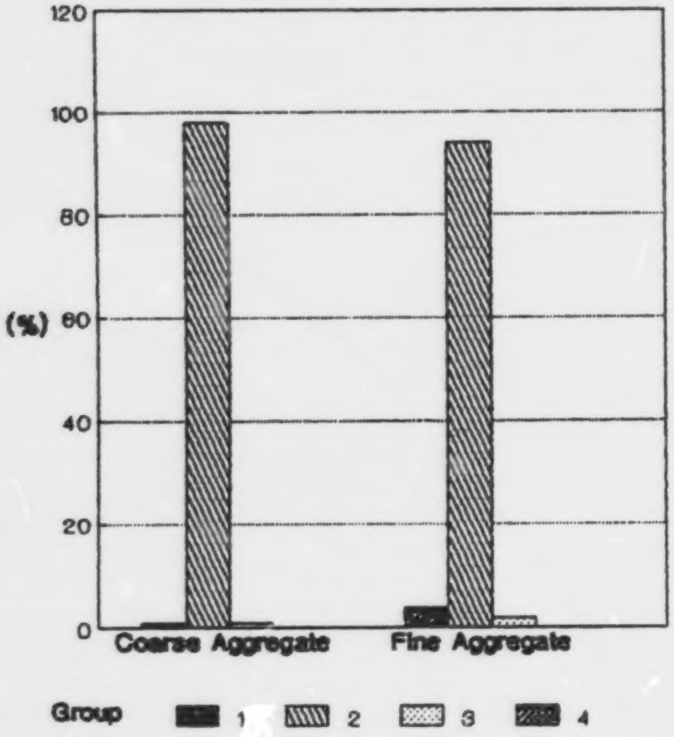
COARSE	CONSTITUENT
Major	Limestone
Intermed.	-
Minor	-
Trace	Dolomite, Granite, Gneiss
FINE	**CONSTITUENT**
Major	Limestone
Intermed.	-
Minor	-
Trace	Dolomite, Shale, Granite

POTENTIAL REACTIVITY	
Group	%
1	1
2	98
3	1
Group	%
1	4
2	94
3	2
4	-

WEATHERING ASSESSMENT: Limestone fragments are slightly argillaceous, and have been subject to surficial weathering.

ALKALI REACTIVITY POTENTIAL: The high content of limestone implies a potential for alkali carbonate reactions. No chert nodules could be identified. Mortar bars and prisms were cast.

Sample 86-6004
St. Anthony



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6005 SOURCE: Stephenville TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	19.2	-	-	I
FINE	1.0	-	2.70	2.26	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Insufficient sample to obtain soundness and abrasion values for coarse and fine fractions. High absorption values for fine aggregate.

PETROGRAPHIC EXAMINATION

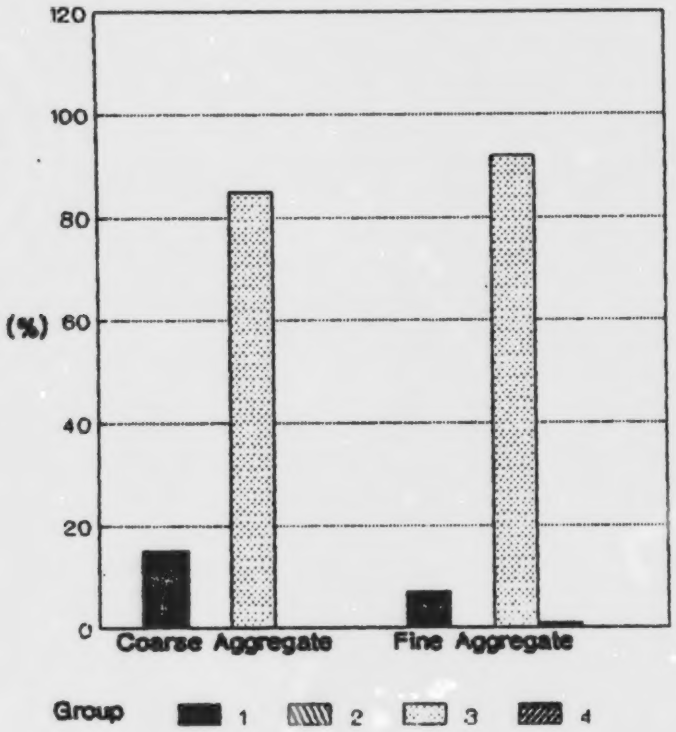
COARSE	CONSTITUENT
Major	-
Intermed.	-
Minor	Mafic volcanic, Basalt, Granite
Trace	Rhyolite, Gabbro, Diorite, Schist
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	Basalt, Mafic volcanic, Sandstone, Granite
Trace	Gabbro,Rhyolite,Schist,Kspar,Quartzite,Dior

POTENTIAL REACTIVITY	
Group	%
1	15
2	-
3	85
Group	**%**
1	7
2	-
3	92
4	1

WEATHERING ASSESSMENT: Sample is unweathered.

ALKALI REACTIVITY POTENTIAL: Wide varieties of lithologies in low percentages. Sample is potentially non-reactive. Mortar bars cast.

Sample 86-6005
Stephenville



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6006 SOURCE: Gallants TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	21.4	2.89	0.39	I
FINE	1.1	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious

COMMENTS: Insufficient sample to obtain soundness and abrasion values for both course and fine fractions.

PETROGRAPHIC EXAMINATION

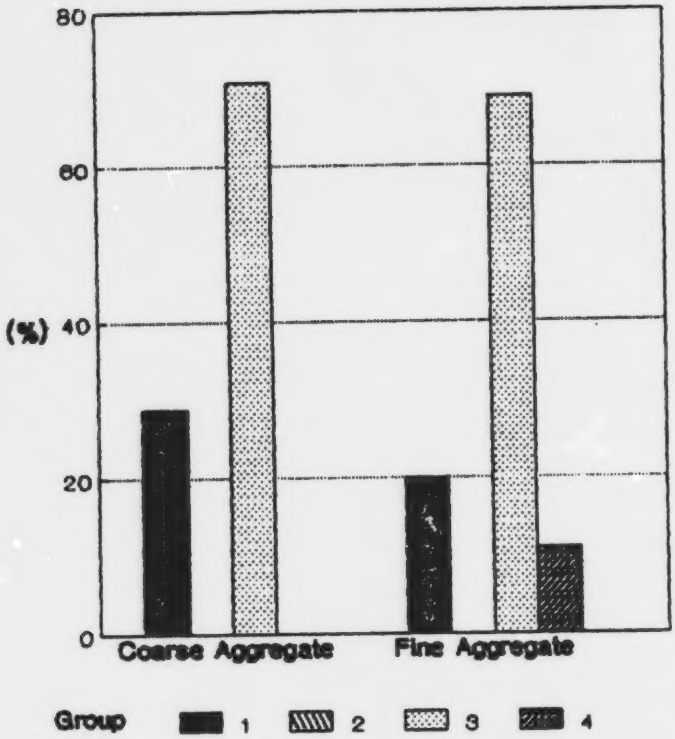
COARSE	CONSTITUENT
Major	-
Intermed.	Diorite, Granite
Minor	Quartzite
Trace	Felsic volcanic ,Rhyolite, Sandstone
FINE	CONSTITUENT
Major	-
Intermed.	Diorite
Minor	Granite,Basalt,Quartzite,Felsic volcanic
Trace	Rhyolite, Schist, Sandstone

POTENTIAL REACTIVITY	
Group	%
1	56
2	-
3	44
Group	%
1	44
2	-
3	44
4	12

WEATHERING ASSESSMENT: Sample is generally unweathered. Minor Fe staining of quartzite was observed. Minor friable schist was observed, and is potentially deleterious.

ALKALI REACTIVITY POTENTIAL: The moderate content of granite suggests the potential for slow-late alkali silicate reactions. Prisms were cast.

Sample 86-6006
Gallants



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6007 SOURCE: Springdale TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	1.5	16.4	2.70	0.44	I
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Only the coarse fraction was provided.

PETROGRAPHIC EXAMINATION

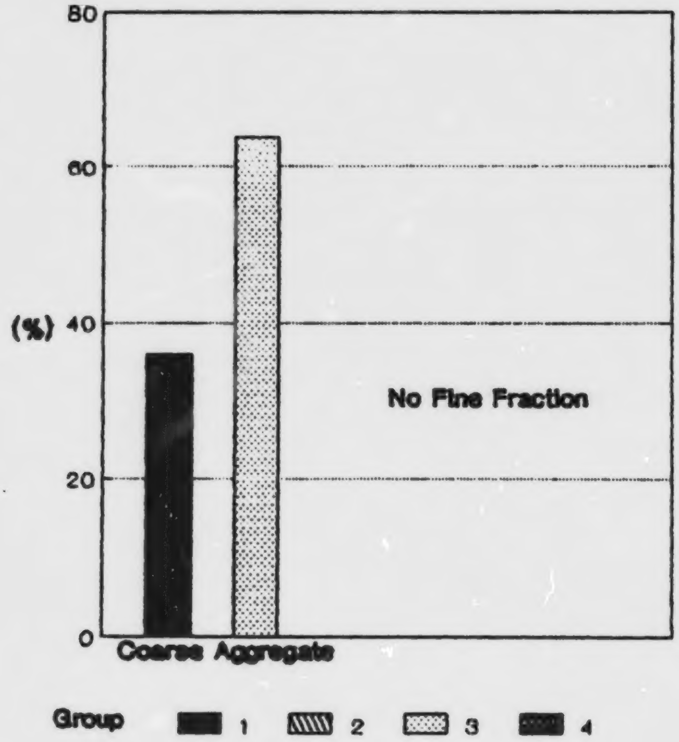
COARSE	CONSTITUENT
Major	-
Intermed.	-
Minor	Granite,Sandstone,Rhyolite,Diorite,Basalt
Trace	Diabase, Quartzite, Gabbro
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	34
2	-
3	66
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Sandstone and rhyolite fragments (<5%) show slight surficial weathering. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: The minor amounts of granitic and sandstone particles suggests a potential for slow-late alkali silicate reactions. Prisms were cast.

Sample 86-6007
Springdale



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6008 SOURCE: Grand Falls TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.1	10.7	2.72	0.4	I
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Only the coarse fraction was provided.

PETROGRAPHIC EXAMINATION

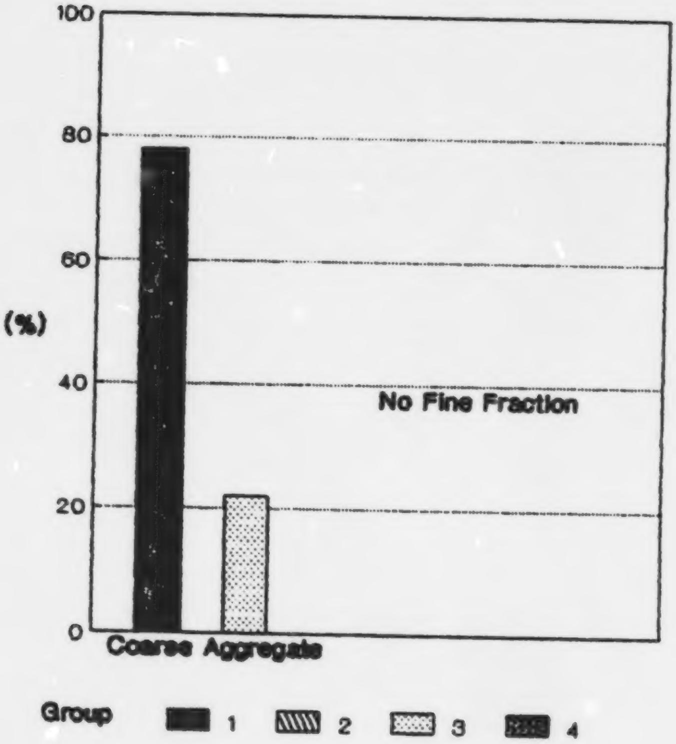
COARSE	CONSTITUENT
Major	-
Intermed.	-
Minor	Felsic volcanics,Sandstone,Siltstone,Dior
Trace	Quartz monzonite, Rhyolite, Quartz, Gabbro
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	78
2	-
3	22
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Approximately 5-10% of the felsic volcanic and rhyolite fragments are slightly weathered.

ALKALI REACTIVITY POTENTIAL: Minor amounts of sandstone and siltstone combine to suggest a potential for slow-late alkali silicate reactions. Prisms were cast.

Sample 86-6008
Grand Falls



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6089 SOURCE: Lewisporte TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.3	16.6	2.73	0.94	I
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Only the coarse fraction was provided.

PETROGRAPHIC EXAMINATION

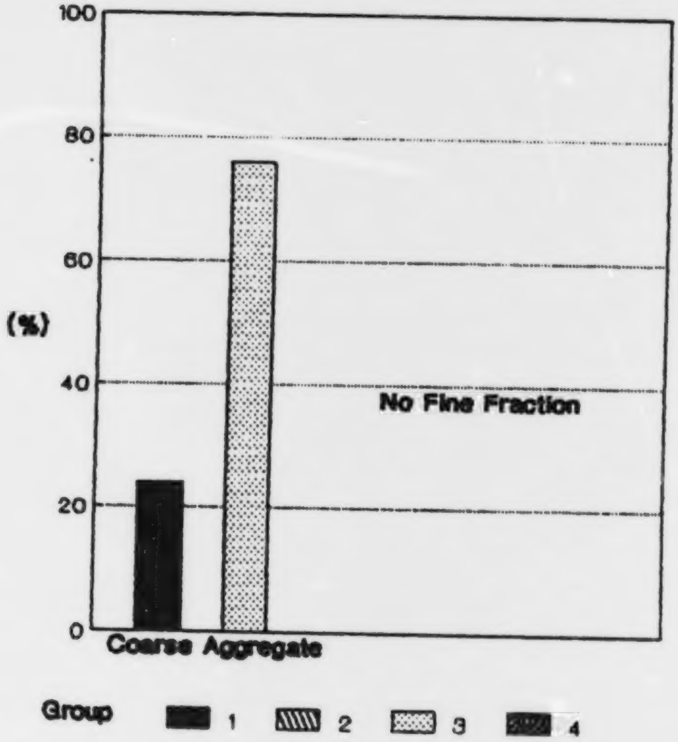
COARSE	CONSTITUENT
Major	-
Intermed.	Diorite
Minor	Granodiorite, Sandstone, Gabbro, Rhyolite
Trace	Basalt, Quartz, Siltstone
FINE	CONSTITUENT
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	24
2	-
3	76
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Approximately 2-5% of the granodiorite fragments show slight surficial weathering. Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: Petrographic analysis of the granodiorite fragments indicates the quartz grains (ca 10-15%) are generally unstrained. The minor content of granitic particles suggests a potential for slow-late alkali silicate reactions. Prisms were cast.

Sample 86-6089
Lewisporte



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6090 SOURCE: Butts Pond TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.0	24.5	2.68	0.42	I
FINE	0.4	-	2.59	2.00	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious

COMMENTS: Abrasion loss (coarse) C535 = 18.3%. High absorption value for fine aggregate.

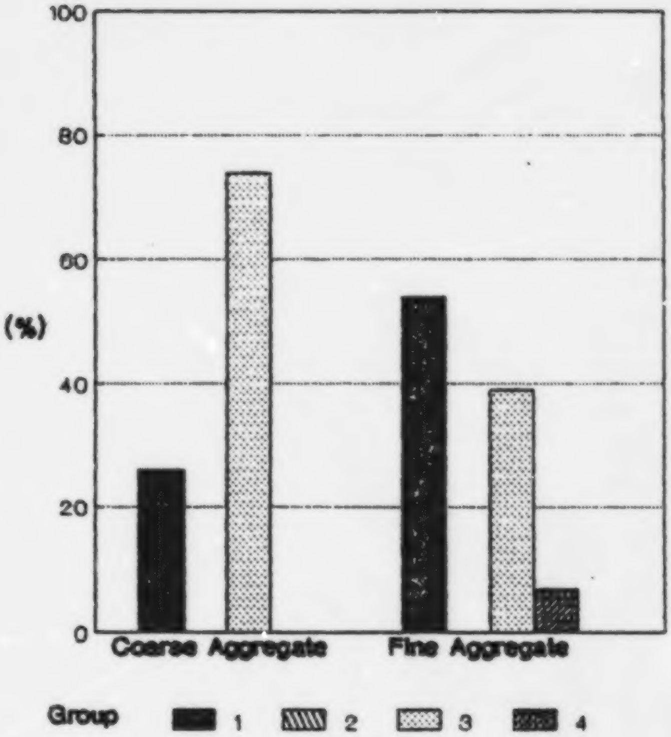
PETROGRAPHIC EXAMINATION

COARSE	CONSTITUENT	POTENTIAL REACTIVITY	
		Group	%
Major	-	1	26
Intermed.	Schist, Granite	2	-
Minor	Granodiorite	3	74
Trace	Quartzite, Schist		
FINE	CONSTITUENT	Group	%
Major	Schist	1	54
Intermed.	-	2	-
Minor	Granite, Granodiorite	3	39
Trace	Quartzite, Potassium feldspar	4	7

WEATHERING ASSESSMENT: Minor amounts (<5%) of schist are slightly weathered and slightly friable. Sample generally appears unweathered.

ALKALI REACTIVITY POTENTIAL: Major to intermediate contents of schist implies possible slow-late alkali silicate reactions. Petrographic analysis of granitic fragments suggests quartz grains are generally unstrained. Prisms were cast.

Sample 86-6090
Butts Pond



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6091 SOURCE: Eastport TYPE: Crushed Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.1	19.3	2.60	0.51	I
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Only the coarse fraction was provided.

PETROGRAPHIC EXAMINATION

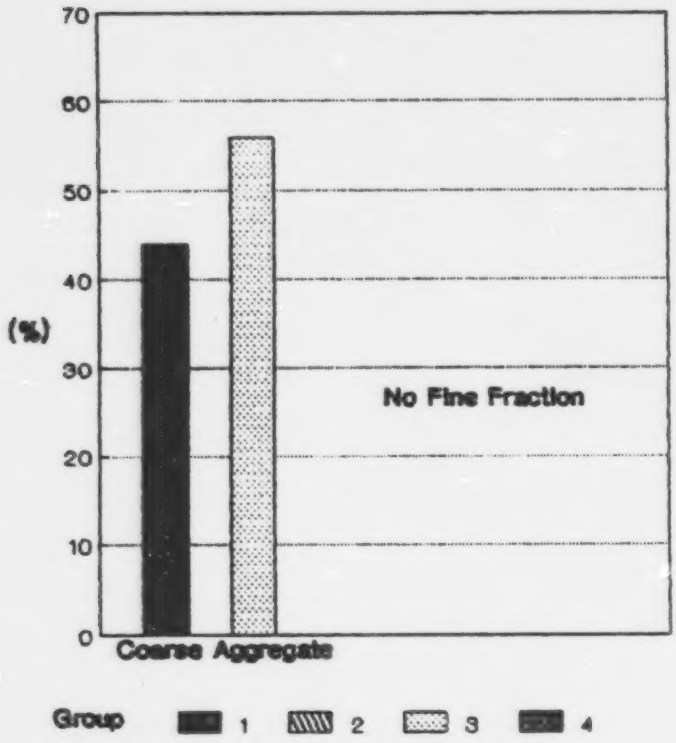
COARSE	CONSTITUENT
Major	-
Intermed.	Granite
Minor	Schist, Sandstone
Trace	Basalt, Siltstone, Gneiss, Quartz
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	44
2	-
3	56
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Sample is unweathered.

ALKALI REACTIVITY POTENTIAL: Petrographic analysis of granite indicates quartz (ca 25%) is unstrained. The minor amounts of schist and sandstone suggest a potential for slow-late alkali silicate reactions. Prisms were cast.

Sample 86-6091
Eastport



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6093 SOURCE: Goose Bay TYPE: Sand and Gravel

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	-	-	2.69	0.61	-
FINE	1.1	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Insufficient sample for abrasion loss testing.

PETROGRAPHIC EXAMINATION

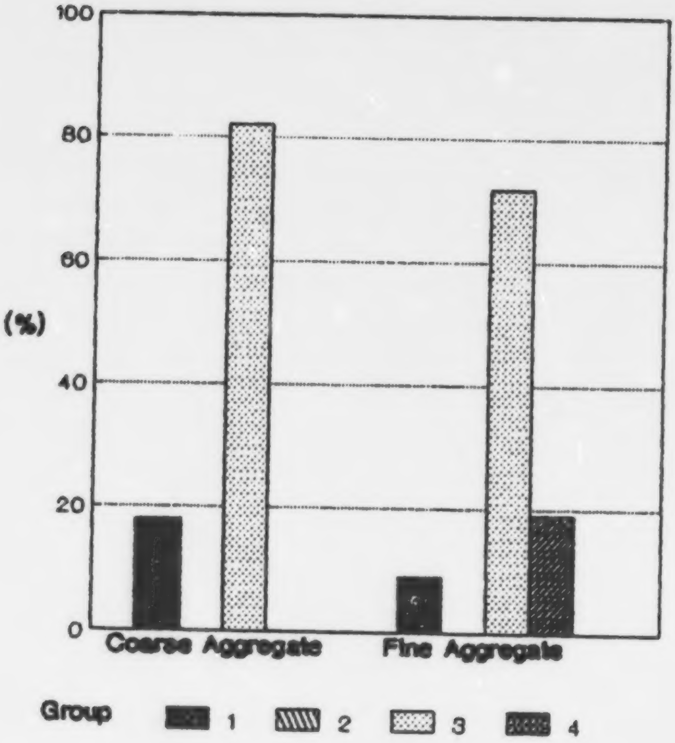
COARSE	CONSTITUENT
Major	Gneiss
Intermed.	-
Minor	Granite
Trace	Diorite, Rhyolite, Quartzite, Basalt
FINE	CONSTITUENT
Major	Gneiss
Intermed.	-
Minor	Quartzite
Trace	Granite, Diorite, Potassium Feldspar,Garnet

POTENTIAL REACTIVITY	
Group	%
1	18
2	-
3	82
Group	%
1	9
2	-
3	72
4	19

WEATHERING ASSESSMENT: Approximately 20% of the gneiss and granite particles exhibit surficial weathering and are friable. The majority of the sample is unweathered.

ALKALI REACTIVITY POTENTIAL: Petrographic analysis indicates the gneiss contains approximately 10-15% quartz, all of which is unstrained. Granitic fragments contain approximately 20% quartz, 80% of which is unstrained, the remainder showing weak undulatory extinction. This suggests the sample is potentially non-reactive. Mortar bars cast.

Sample 86-6093
Goose Bay



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6094 SOURCE: Marystown TYPE: Gravel

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.2	13.4	2.65	0.99	-
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Only sufficient sample to test coarse aggregate.

PETROGRAPHIC EXAMINATION

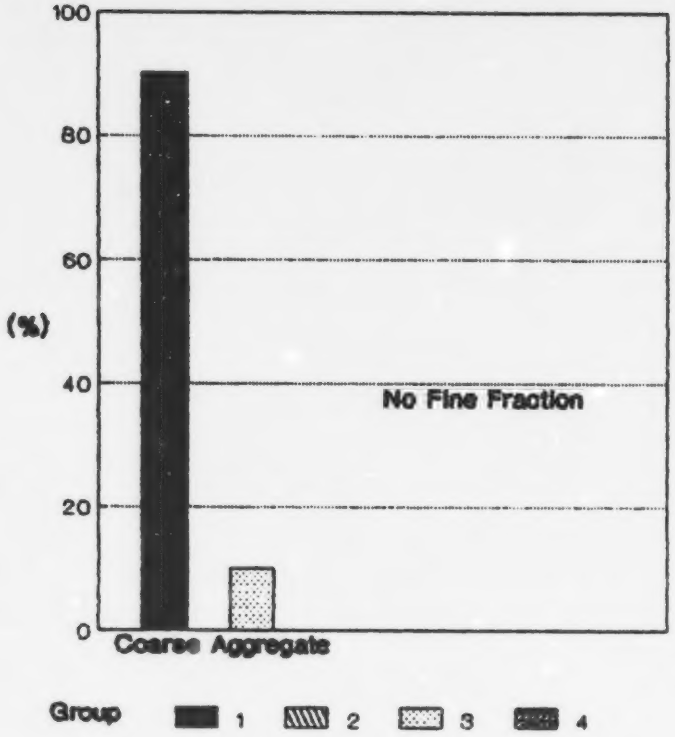
COARSE	CONSTITUENT
Major	Felsic volcanic
Intermed.	Rhyolite
Minor	-
Trace	Granite, Basalt, Gabbro, Diorite, Sandst, Quartz
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	90
2	-
3	10
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Small percentages of felsic volcanic and gabbro are slightly weathered.

ALKALI REACTIVITY POTENTIAL: High siliceous volcanogenic component suggests potential for alkali silica reactions. Mortar bars cast.

Sample 86-6094
Marystown



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6095 SOURCE: Clarenville TYPE: Gravel

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.04	14.7	2.70	0.4	-
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Only sufficient sample to test the coarse aggregate.

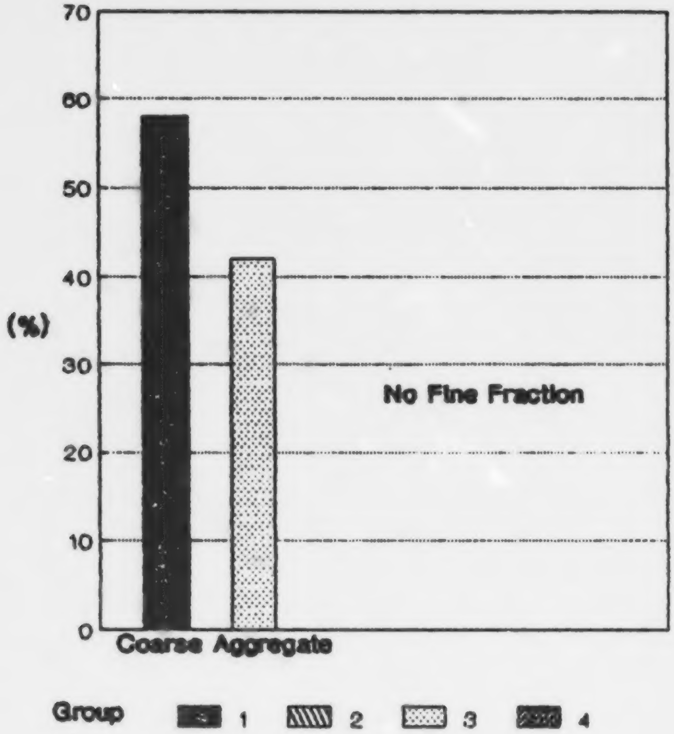
PETROGRAPHIC EXAMINATION

COARSE	CONSTITUENT	POTENTIAL REACTIVITY	
		Group	%
Major	-	1	58
Intermed.	Tuffaceous sandstone/volcaniclastic	2	-
Minor	Granite, Diorite, Siltstone	3	43
Trace	Gabbro, Gneiss, Schist, Basalt, Quartz		
FINE	CONSTITUENT	Group	%
Major	-	1	-
Intermed.	-	2	-
Minor	-	3	-
Trace	-	4	-

WEATHERING ASSESSMENT: Generally unweathered, some fragments are slightly sericitized. Some sandstone fragments have clay coatings.

ALKALI REACTIVITY POTENTIAL: The intermediate content of sandstone fragments indicate a probable slow-late reaction. Concrete prisms and mortar bars were cast.

Sample 86-6095
Clarenville



AGGREGATE SUMMARY SHEET

SAMPLE No.: 86-6096 SOURCE: Wabush TYPE: Sand and Gravel

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	0.2	26.1	2.70	0.48	-
FINE	0.4	-	2.61	1.81	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious

COMMENTS: Only sufficient sample to test coarse aggregate.

PETROGRAPHIC EXAMINATION

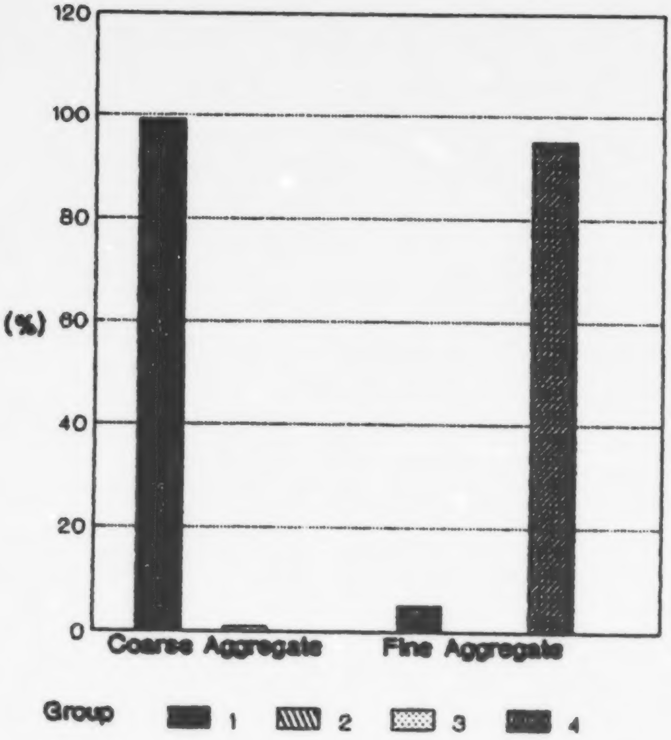
COARSE	CONSTITUENT
Major	Quartzite
Intermed.	-
Minor	-
Trace	Schist, Amphibole
FINE	**CONSTITUENT**
Major	Quartzite
Intermed.	-
Minor	-
Trace	Muscovite

POTENTIAL REACTIVITY	
Group	%
1	100
2	-
3	-
Group	%
1	5
2	-
3	-
4	95

WEATHERING ASSESSMENT: Iron oxidation is common of quartz fragments. Muscovite common along some fractures.

ALKALI REACTIVITY POTENTIAL: Alkali silica reaction is possible. Concrete prisms and mortar bars were cast.

Sample 86-6096
Wabush



AGGREGATE SUMMARY SHEET

SAMPLE No.: 88 GA01 SOURCE: Seal Cove TYPE: Sand and Gravel

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	2.0	16.8	2.63	0.66	-
FINE	4.0	-	2.55	1.37	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Sample meets general specification requirements.

PETROGRAPHIC EXAMINATION

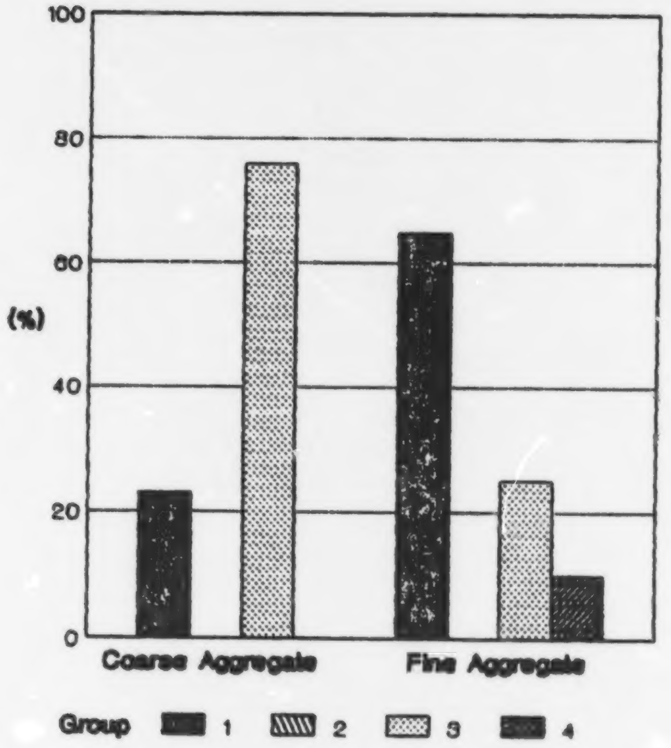
COARSE	CONSTITUENT
Major	-
Intermed.	Granite, Leucogranite
Minor	Mafic volcanic
Trace	Sandstone, Siltstone, Diabase, Rhyolite
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	Granite,Leucogranite,Mafic volcanic,Quartz
Trace	Sandstone, Siltstone

POTENTIAL REACTIVITY	
Group	%
1	23
2	-
3	76
Group	%
1	65
2	-
3	25
4	10

WEATHERING ASSESSMENT: Sample is generally unweathered. Minor clay coating on ~20% of fragments.

ALKALI REACTIVITY POTENTIAL: Slow-late reactions are possible. Mortar bars and prisms were cast.

Sample 88-GA01
Seal Cove



AGGREGATE SUMMARY SHEET

SAMPLE No.: 88 GA02 SOURCE: St. John's TYPE: Sand and Gravel

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	3.0	12.7	2.10	0.79	-
FINE	6.8	-	2.67	0.69	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious

COMMENTS: Sample meets general specification requirements.

PETROGRAPHIC EXAMINATION

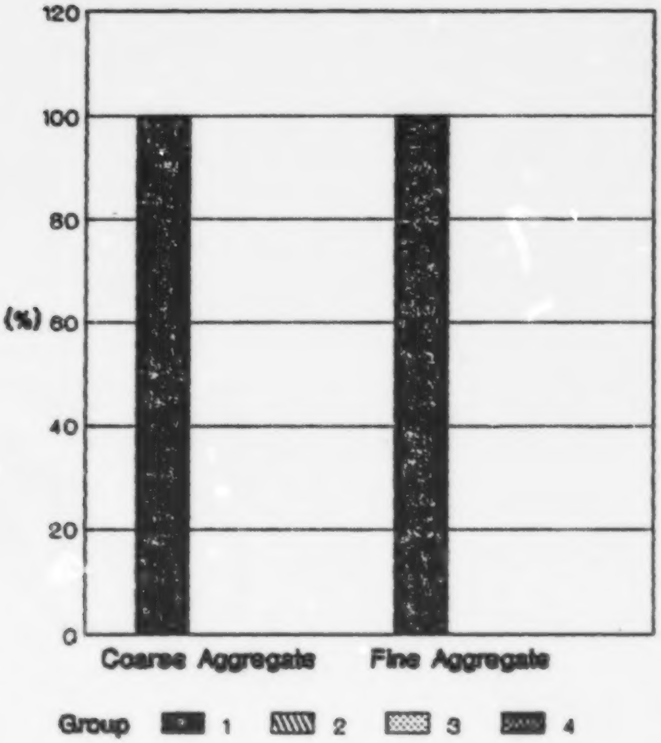
COARSE	CONSTITUENT
Major	Sandstone
Intermed.	-
Minor	Siltstone
Trace	-
FINE	**CONSTITUENT**
Major	Sandstone
Intermed.	-
Minor	-
Trace	Siltstone

POTENTIAL REACTIVITY	
Group	%
1	100
2	-
3	-
Group	%
1	100
2	-
3	-
4	-

WEATHERING ASSESSMENT: Clay coating is evident on 90% of fragments.

ALKALI REACTIVITY POTENTIAL: Slow-late reactions are possible. Mortar bars and prisms were cast.

Sample 88-GA02
St. John's



AGGREGATE SUMMARY SHEET

SAMPLE No.: 88 GA03 SOURCE: Mackisons TYPE: Sand and Gravel

PHYSICAL PROPERTIES

	Soundness Loss (C88) %	Abrasion Loss (C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	6.45	13.0	2.67	0.88	-
FINE	9.06	-	2.58	2.21	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Sample generally meets physical specification requirements.

PETROGRAPHIC EXAMINATION

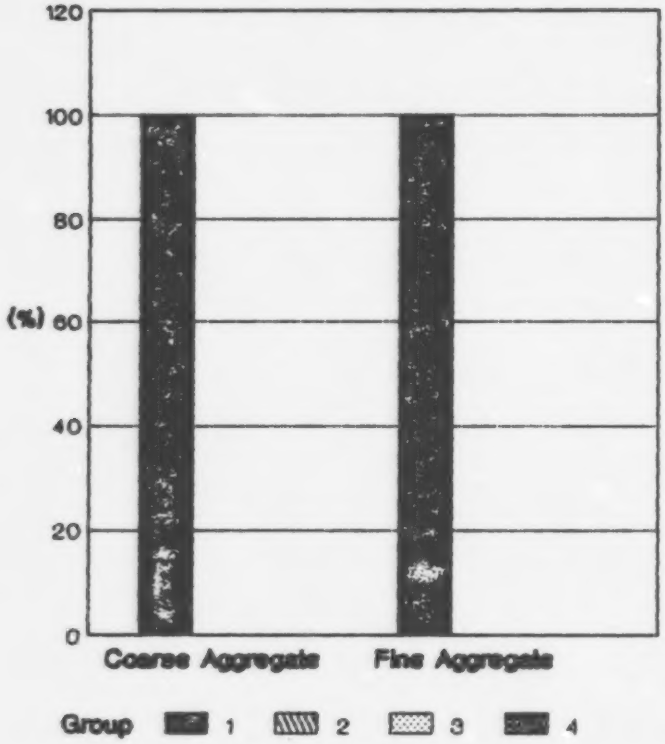
COARSE	CONSTITUENT
Major	Siltstone
Intermed.	Sandstone
Minor	-
Trace	-
FINE	**CONSTITUENT**
Major	Siltstone
Intermed.	-
Minor	Sandstone
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	100
2	-
3	-
Group	%
1	100
2	-
3	-
4	-

WEATHERING ASSESSMENT: Sample is generally unweathered.

ALKALI REACTIVITY POTENTIAL: The siliceous siltstone and sandstone indicate possible alkali silica and alkali silicate expansions. Mortar bars and prisms were cast.

Sample 88-GA03
Mackisons



AGGREGATE SUMMARY SHEET

SAMPLE No.: 88 GA04 SOURCE: Pipers Hole TYPE: Gravel

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE		-	2.67	1.42	-
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Sample is within physical specification requiements.

PETROGRAPHIC EXAMINATION

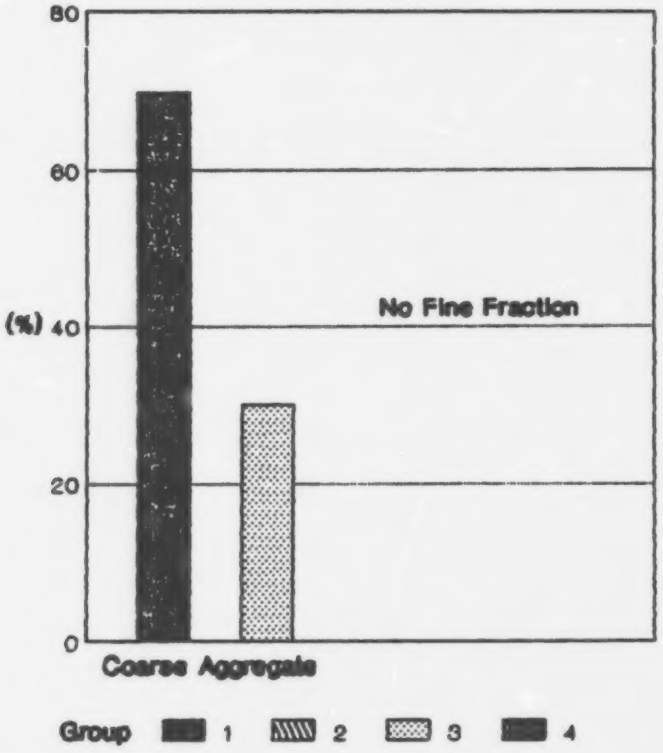
COARSE	CONSTITUENT
Major	-
Intermed.	Sandstone
Minor	-
Trace	Rhyo.,Felsic tuff,Granite,Mafic volc, Dior.
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	70
2	-
3	30
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Particles are generally unweathered. Slight clay coating is evident on 90% of fragments.

ALKALI REACTIVITY POTENTIAL: High sandstone content implies potential slow-late reaction.

Sample SS-GA04
Pipers Hole



AGGREGATE SUMMARY SHEET

SAMPLE No.: 88 GA05 SOURCE: Swift Current TYPE: Rock

PHYSICAL PROPERTIES

	Soundness Loss(C88) %	Abrasion Loss(C131, C535) %	Relative Density (C127,128)	Absorption (C127,128) %	Quick Chemical (C289)*
COARSE	1.65	24.5	2.64	0.57	-
FINE	-	-	-	-	-

* I = Innocuous, D = Deleterious, P.D. = Potentially Deleterious
COMMENTS: Abrasion loss is high.

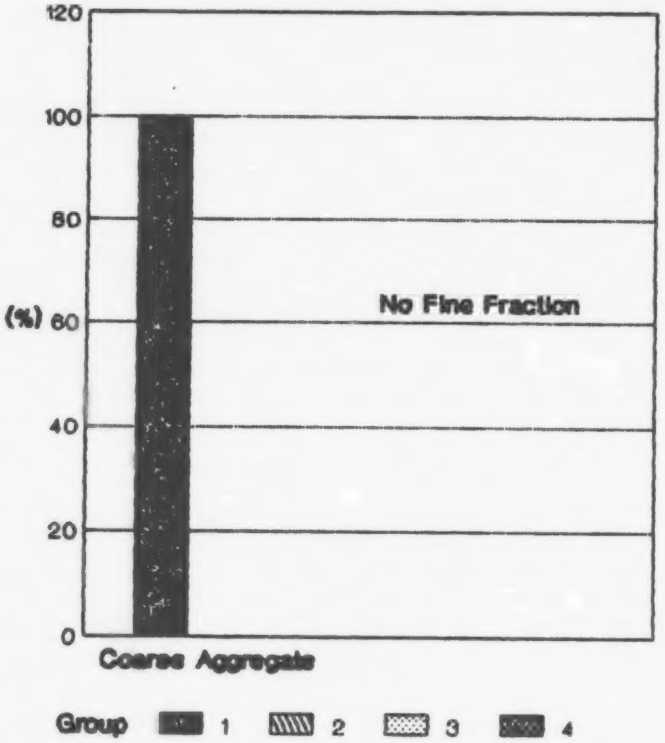
PETROGRAPHIC EXAMINATION

COARSE	CONSTITUENT
Major	Granite
Intermed.	-
Minor	-
Trace	-
FINE	**CONSTITUENT**
Major	-
Intermed.	-
Minor	-
Trace	-

POTENTIAL REACTIVITY	
Group	%
1	100
2	-
3	-
Group	%
1	-
2	-
3	-
4	-

WEATHERING ASSESSMENT: Sample taken from roadside outcrop. Generally unweathered.

ALKALI REACTIVITY POTENTIAL: Slow-late reactions are possible. Concrete prisms were cast.



Sample 88-GA05
Swift Current

Nova Scotia Research Foundation Corporation

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APPLIED SCIENCE DIVISION

ANALYTICAL CHEMISTRY LABORATORY REPORT

CLIENT: Golder Assoc.
716 Water Street
St. John's, Nfld.

DATE SUBMITTED July 14, 1986

Att: Mr. Derek Peper

MATERIAL: Aggregates

DATE REPORTED: Aug. 29, 1986

LAB. No.	DESCRIPTION	*Dissolved Silica Sc (Millimoles/Liter)	*Reduction in Alkalinity Rc (Millimoles/Liter)
P184/1	85-3017-R	28.97	47.20
P184/2	85-3032-R	23.20	50.27
P184/3	85-3037-R	17.57	39.16
P184/4	85-3058-R	25.64	42.07
P184/5	85-3066-R	17.32	39.33
P184/6	85-3161-R	22.87	38.47
P184/7	85-3047-R	17.98	36.42
P184/8	85-3006-R	16.98	58.14
P184/9	85-3065	20.40	44.12
P184/10	85-3050-R	17.54	45.49
P184/11	85-3008-R	31.41	51.98
P184/12	85-6200-B Site 167	69.60	79.17
P184/13	85-6213 B Site 180	61.50	70.28
P184/14	85-6214-B	87.03	62.76
P184/15	85-6215-B Site 182	80.81	54.72
P184/16	85-6216-B	127.54	71.82

*Average Values

...../2

Director, Analytical & Environmental Chemistry

Nova Scotia Research Foundation Corporation

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APPLIED SCIENCE DIVISION

ANALYTICAL CHEMISTRY LABORATORY REPORT

CLIENT: Golder Assoc.

DATE SUBMITTED July 14, 1986

MATERIAL: Aggregates

DATE REPORTED: Aug. 29, 1986

LAB. No.	DESCRIPTION	Interpretation of Results Fig.2 ASTM C-289-71
P184/1	85-3017-R	Innocuous
P184/2	8503032-R	Innocuous
P184/3	85-3037-R	Innocuous
P184/4	85-3058-R	Innocuous
P184/5	85-3066-R	Innocuous
P184/6	85-3161-R	Innocuous
P184/7	85-3047-R	Innocuous
P184/8	85-3006-R	Innocuous
P184/9	85-3065	Innocuous
P184/10	85-3050-R	Innocuous
P184/11	85-3008-R	Innocuous
P184/12	85-6200-B Site 167	Deleterious
P184/13	85-6213-B Site 180	Deleterious
P184/14	85-6214-B	Deleterious
P184/15	85-6215-B Site 182	Deleterious
P184/16	85-6216-B	Deleterious

86/09/03

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APPLIED SCIENCE DIVISION

ANALYTICAL CHEMISTRY LABORATORY REPORT

CLIENT: Golder Assoc.
716 Water Street
St. John's, Nfld.

DATE SUBMITTED Sept.4, 1986

Attn: Mr. Derek Peper

MATERIAL: Aggregates

DATE REPORTED: Oct. 3, 1986

LAB. No.	DESCRIPTION	*Dissolved Silica Sc (Millimoles/Liter)	*Reduction in Alkalinity Rc (Millimoles/Liter)
P365/1	6001 A (1.5")	23.53	39.50
P365/2	6001 B	21.31	48.90
P365/3	6002	10.10	32.49
P365/4	6003	8.15	42.92
P365/5	6004	18.98	119.19
P365/6	6005	13.76	51.81
P365/7	6006	13.99	40.36
P365/8	6007	20.98	62.93
P365/9	6008	35.52	64.47
P365/10	6089	16.76	63.78
P365/11	6090	12.88	124.49
P365/12	6091	16.54	63.37

* Average Values

.../2

86/10/06

Director, Analytical & Environmental Chemistry

Nova Scotia Research Foundation Corporation

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Telex 019-22719

APPLIED SCIENCE DIVISION

ANALYTICAL CHEMISTRY LABORATORY REPORT

CLIENT: Golder Assoc.

DATE SUBMITTED Sept. 4, 1986

MATERIAL: Aggregates

DATE REPORTED: Oct. 3, 1986

LAB. No.	DESCRIPTION	Interpretation of Results Fig.2 ASTM C-289-71
P365/1	6001 A	Innocuous
/2	6001 B	Innocuous
/3	6002	Innocuous
/4	6003	Innocuous
/5	6004	Innocuous
/6	6005	Innocuous
/7	6006	Innocuous
/8	6007	Innocuous
/9	6008	Innocuous
/10	6089	Innocuous
/11	6090	Innocuous
/12	6091	Innocuous

Director, Analytical & Environmental Chemistry

APPENDIX 'C'

PETROGRAPHIC EXAMINATION DATA

C - 1	Particle Count Sheets
C - 2	Thin Section Analysis Section I Section II

STUDY OF THE ALKALI REACTIVITY OF POTENTIAL CONCRETE AGGREGATE OF NEWFOUNDLAND

TABLE C1

PETROGRAPHIC EXAMINATION INDEX

Sample No.	Particle Count Analysis	Thin Section Analysis of Selected Particles
85 3006	X	X
85 3008	X	
85 3017	X	X 0
85 3032	X	0
85 3047	X	X
85 3050	X	X
85 3058	X	0
85 3065	X	X
85 3066	X	0
85 3161	X	X
85 6200		
85 6213		0
85 6214		
85 6215		
85 6216		
86 6001	X	X
86 6002	X	X

TABLE C1 (cont'd)

Sample No.	Particle Count Analysis	Thin Section Analysis of Selected Particles
86 6003	X	
86 6004	X	0
86 6005	X	X
86 6006	X	X 0
86 6007	X	
86 6008	X	
86 6089	X	X
86 6090	X	0
86 6091	X	X
86 6093	X	X 0
86 6094	X	X
86 6095	X	
86 6096	X	0
88 GA01	X	X
88 GA02	X	
88 GA03	X	
88 GA04	X	
88 GA05		

X Analysis by Golder Associates personnel

0 Analysis by F. Mengel, Ph.D. (Sub Consultant to Golder Associates)

APPENDIX 'C'

Particle Count Method

NOTES:

1. ASTM C 294 and C 295 were followed as closely as possible.
2. The physical condition and quantity of the sample dictated the grading and therefore number of particles examined per fraction.
3. The following gradings were determined to be suitable prior to obtaining sieve fractions.

	GRADING	SIEVE OPENING SIZE
Coarse	A	25.4 - 19.0 mm
	B	19.0 - 12.7 mm
	C	12.7 - 9.5 mm
	D	9.5 - 4.75 mm
Fine	E	4.75 - 2.36 mm
	F	2.36 - 1.18 mm
	G	1.18 - 0.85 mm

4. A percentage is provided adjacent to each rock type. This gives an indication of the relative proportion of each constituent within the context of the bulk sample. It should be noted that for many samples, separate containers of coarse aggregate and fine aggregate were obtained and gradations obtained from these samples separately. It is therefore conceivable that the percentages may add up to greater than 100 percent.
5. Lithological descriptions are provided in the lower table. The categories are those suggested by ASTM C 295.

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 85-3006 LOCATION: Swift Current TYPE: Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	4.75 mm		2.36 mm		850 um	
	PART.	%	PART.	%	PART.	%
Volcaniclastic	201	67.0	210	70.0	201	67.0
Alt.Felsic Vol	9	3.0	3	1.0	-	-
Granite 1	30	10.0	30	10.0	15	5.0
Granite 2	4	1.3	-	-	-	-
Sandstone	17	5.7	27	9.0	15	5.0
Siltstone	2	0.7	1	0.3	-	-
Rhyolite	27	9.0	21	7.0	30	10.0
Quartz	2	0.7	7	2.4	37	12.3
Schist	1	0.3	-	-	-	-
Diorite	7	2.3	1	0.3	2	0.7

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Volcaniclastic	Subround	Fresh	Grey	Hard
Alt.Felsic Vol	Subround	Slightly wx	Grey	Hard, some clay coating
Granite 1	Subangular	Fresh	Pink	Medium, grained, hard
Granite 2	Subangular	Slightly wx	Brown	Hard
Sandstone	Subround	Fresh	Brown	Hard
Siltstone	Subround	Fresh	Red	Hard, dense
Rhyolite	Subround	Fresh	Buff	Hard
Quartz	Subangular	Fresh	White	Medium grained, hard
Schist	Subround	Fresh	Grey	Hard
Diorite	Subangular	Fresh	Green	

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 85-3017 LOCATION: Swift Current TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	9.52 mm		4.75 mm		2.36 mm		850 um					
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Mafic Volcanic	167	55.6	161	53.7	137	45.7	121	40.3				
Mafic Volcanic	12	4.0	11	3.7	10	3.3	2	0.7				
Rhyolite	24	8.0	46	15.3	45	15.0	39	13.0				
Granite 1	39	13.0	39	13.0	53	17.7	54	18.0				
Granite 2	3	1.0	5	1.7	10	3.3	4	1.3				
Quartz	2	0.3	1	0.3	7	2.3	55	18.3				
Diorite	3	1.0	3	1.0	5	1.7	7	2.3				
Schist	3	1.0	4	1.3	3	1.0	-	-				
Sandstone	36	12.0	25	8.3	24	8.0	18	6.0				
Siltstone	12	4.0	5	1.7	6	2.0	-	-				

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Mafic Volcanic	Subangular	Fresh	Grey	Hard
Mafic Volcanic	Subangular	Slightly wx	Grey	Hard, occasional clay coating
Rhyolite	Subangular	Fresh	Grey	Hard, dense
Granite 1	Subangular	Fresh	Pink	Hard, medium grained
Granite 2	Subangular	Slightly wx	Pink	Medium grained, hard
Quartz	Angular	Fresh	White	Medium grained, hard
Diorite	Subround	Slightly wx	Grey	Hard
Schist	Subround	Medium wx	Grey	Slightly friable,pot. deleterious
Sandstone	Subround	Fresh	Grey	Hard
Siltsstone	Subround	Fresh	Grey	Hard, dense

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 85-3032 LOCATION: Swift Current TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	9.53 mm		4.75 mm		2.36 mm		850 um					
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Felsic Volc. 1	211	70.3	198	66.0	186	62.0	186	62.0				
Felsic Volc. 2	12	4.0	18	6.0	12	4.0	6	2.0				
Granite 1	18	6.0	27	9.0	30	10.0	24	8.0				
Granite 2	-	-	2	0.7	1	0.3	-	-				
Sandstone 1	18	6.0	18	6.0	23	7.7	24	8.0				
Sandstone 2	-	-	2	0.7	1	0.3	1	0.3				
Siltstone	6	2.0	3	1.0	5	1.7	9	3.0				
Phyolite	18	6.0	21	7.0	24	8.0	18	60.0				
Schist	-	-	3	1.0	1	0.3	-	-				
Quartz	2	0.7	2	0.7	12	4.0	27	9.0				
Diorite	15	5.0	6	2.0	5	1.7	5	1.7				

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Felsic Volc. 1	Subround	Fresh	Grey	Dense, hard
Felsic Volc. 2	Subround	Slightly wx	Brown	Hard
Granite 1	Angular	Fresh	Grey	Hard, medium grained
Granite 2	Angular	Slightly wx	Grey	Hard
Sandstone 1	Subround	Fresh	Brown	Hard
Sandstone 2	Subround	Slightly wx	Brown	Hard, potentially deleterious
Siltstone	Subround	Fresh	Red	Hard, dense
Phyolite	Subround	Fresh	Buff	Hard, dense
Schist	Subround	Fresh	Grey	Hard
Quartz	Subround	Fresh	White	Hard
Diorite	Subround	Fresh	Green	Hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 85-3008 LOCATION: Swift Current TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	12.7 mm		9.52 mm		4.75 mm		1.18 mm					
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Mafic Volcanic	200	66.7	179	59.6	177	59.1	165	60.0				
Mafic Volcanic	14	4.7	9	3.0	9	3.0	–	–				
Grainte 1	52	17.3	47	15.7	45	15.0	57	20.8				
Granite 2	2	0.7	6	2.0	3	1.0	–	–				
Sandstone	17	5.6	23	7.7	26	8.7	21	7.6				
Siltstone	–	–	3	1.0	4	1.3	–	–				
Rhyolite	14	4.7	25	8.3	23	7.7	–	–				
Quartz	1	0.3	1	0.3	5	1.7	30	10.8				
Schist	–	–	3	1.0	1	0.3	–	–				
Diorite	–	–	4	1.3	7	2.3	4	1.4				

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Mafic Volcanic	Subangular	Fresh	Grey	Hard
Mafic Volcanic	Subangular	Slightly wx	Grey	Hard, occasional porous
Granite 1	Angular	Fresh	Grey	Medium grained, hard
Granite 2	Angular	Slightly wx	Buff	Clay coating
Sandstone	Subround	Fresh	Brown	Hard
Siltstone	Subround	Fresh	Brown	Hard, dense
Rhyolite	Subangular	Fresh	Buff	Hard, dense
Quartz	Subround	Fresh	White	Hard, medium grained
Schist	Subround	Fresh	Grey	Hard
Diorite	Subround	Fresh	Green	Hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 85-3047 LOCATION: Swift Current TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	12.7 mm		4.75 mm		2.36 mm							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Mafic Volcanic	69	23.0	70	23.3	75	25.0						
Mafic Volcanic	8	2.7	7	2.3	5	1.6						
Granite 1	67	22.3	76	25.3	71	23.7						
Granite 2	7	2.3	2	0.7	5	1.7						
Rhyolite 1	34	11.3	22	7.3	34	11.3						
Quartz	–	–	2	0.7	16	5.3						
Basalt	18	6.0	21	7.0	17	5.7						
Gabbro	11	3.7	29	9.7	18	6.0						
Diorite	44	14.7	56	18.7	45	15.0						
Sandstone 1	16	5.3	6	2.0	5	1.7						
Sandstone 2	2	0.7	–	–	–	–						
Siltstone	7	2.3	–	–	–	–						
Schist	8	2.7	8	2.7	8	2.7						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Mafic Volcanic	Subround	Fresh	Green	Hard, lithic fragments
Mafic Volcanic	Subround	Slightly wx	Green	Hard, clay coating
Granite 1	Subround	Fresh	Grey	Medium grained, hard
Granite 2	Subangular	Slightly wx	Grey	Occasional sericitized, hard
Rhyolite 1	Subround	Fresh	Green	Siliceous, dense
Rhyolite 2	Subround	Slightly wx	Green	Hard
Quartz	Subangular	Fresh	Clear	Hard
Basalt	Round	Fresh	Grey	Hard
Gabbro	Subangular	Fresh	Grey	Hard, medium grained
Diorite	Subround	Fresh	Green	Hard
Sandstone 1	Round	Fresh	Red	Hard
Sandstone 2	Subround	Slightly wx	Brown	Firm
Siltstone	Subround	Fresh	Grey	Hard
Schist	Subround	Fresh	Green	Hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 85-3050 LOCATION: Swift Current TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	6.35 mm		4.75 mm		1.18 mm							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Volcanoclastic	121	40.3	154	51.3	81	27.0						
Mafic Volcanic	11	3.7	11	3.7	3	1.0						
Rhyolite 1	45	15.0	34	11.2	30	10.0						
Rhyolite 2	2	0.7	3	1.0	-	-						
Granite 1	44	14.7	35	11.7	57	19.0						
Granite 2	7	2.3	2	0.7	3	1.0						
Basalt	28	9.3	26	8.7	24	8.0						
Quartz	1	0.3	1	0.3	48	16.0						
Diorite	17	5.7	7	2.3	30	10.0						
Gabbro	-	-	3	1.0	-	-						
Sandstone	15	5.0	11	3.7	12	4.0						
Siltstone	6	2.0	8	2.7	6	2.0						
Schist	2	0.7	5	1.7	6	2.0						
Syenite	1	0.3	-	-	-	-						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Volcanoclastic	Subround	Fresh	Green	Lithic fragments, hard
Mafic Volcanic	Subround	Slightly wx	Green	
Rhyolite 1	Subround	Fresh	Buff	Hard, dense
Rhyolite 2	Subround	Slightly wx	Buff	Hard
Granite 1	Subangular	Fresh	Grey	Equigranular, hard
Granite 2	Subangular	Slightly wx	Grey	Occasional sericitized
Basalt	Round	Fresh	Grey	Amygdaloidal, hard
Quartz	Round	Fresh	Clear	Hard
Diorite	Subround	Fresh	Green	Abundant olivine
Gabbro	Subangular	Fresh	Grey	Medium garined, hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 85-3058 LOCATION: Swift Current TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	9.53 mm		4.75 mm		2.36 mm		850 um					
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Mafic Volcanic	168	56.0	186	62.0	176	58.7	162	54.0				
Mafic Volcanic	12	4.0	12	4.0	9	3.0	6	2.0				
Granite 1	51	17.0	18	6.0	42	14.0	48	16.0				
Granite 2	6	2.0			9	3.0						
Sandstone 1	24	8.0	34	11.3	18	6.0	15	5.0				
Sandstone 2	6	2.0	9	3.0	3	1.0	3	1.0				
Siltstone	1	0.3	3	1.0								
Rhyolite	20	1.6	31	10.3	27	9.0	39	13.0				
Quartz			2	0.7	9	3.0	21	7.0				
Schist	1	0.3	2	0.7	1	0.3	1	0.3				
Diorite	2	0.7	3	1.0	6	2.0	5	1.7				

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Mafic Volcanic	Subangular	Fresh	Grey	Hard
Mafic Volcanic	Subangular	Slightly wx	Grey	Hard, clay coating
Granite 1	Subangular	Fresh	Pink	Hard
Granite 2	Subangular	Slightly wx	Brown	Hard
Sandstone 1	Subround	Fresh	Brown	Hard
Sandstone 2	Subround	Slightly wx	Brown	Hard,clay coating,pote.deleterious
Siltstone	Subround	Fresh	Red	Hard, dense
Rhyolite	Subround	Fresh	Buff	Hard
Quartz	Subangular	Fresh	White	Hard, medium grained
Schist	Subround	Fresh	Grey	Hard
Diorite	Subround	Fresh	Green	Hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 83-3065 LOCATION: Piper's Hole TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	19.0 mm		9.52 mm		4.75 mm		850 um					
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Tuffaceous	47	47.0	150	50.0	168	56.0	130	43.3				
Sed/Volcanicl.	11	11.0	8	2.7	6	2.0	8	2.7				
Rhyolite	14	14.0	43	14.3	29	9.7	31	10.3				
Sandstone 1	13	13.0	36	12.0	36	12.0	17	5.7				
Sandstone 2	1	1.0	2	0.7	3	1.0	1	0.3				
Siltstone	2	2.0	12	4.0	7	2.3	5	1.7				
Granite 1	7	7.0	33	11.0	32	10.7	72	24.0				
Granite 2			2	0.7	8	2.7	2	0.7				
Diorite	2	2.0	5	1.7	2	0.7	2	0.7				
Quartz	1	1.0	6	2.0	3	1.0	31	10.3				
Schist	2	2.0	3	1.0	6	2.0	1	0.3				

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Tuffaceous	Subangular	Fresh	Grey	Hard
Sed/Volcanicl.	Subangular	Slightly wx	Grey	Hard, clay coating
Rhyolite	Subangular	Fresh	Grey	Hard, dense
Sandstone 1	Subround	Fresh	Red	Hard
Sandstone 2	Subround	Slightly wx	Brown	Hard, clay coating
Siltstone	Subangular	Fresh	Grey	Hard, dense
Granite 1	Subround	Fresh	Pink	Medium grained, hard
Granite 2	Subround	Slightly wx	Pink	Hard, clay coating
Diorite	Subround	Fresh	Green	Hard
Quartz	Subangular	Fresh	White	Hard, medium grained
Schist	Subround	Fresh	Green	Hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 85-3066 LOCATION: Piper's Hole TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	12.7 mm		4.75 mm		1.18 mm							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Felsic Tuff 1	14	18.7	31	12.7	28	9.3						
Felsic Tuff 2	1	1.3	10	3.3	8	2.7						
Rhyolite	7	9.3	12	4.0	26	8.7						
Granite 1	11	14.6	20	6.7	40	13.2						
Granite 2	2	2.7										
Mafic Volcanic	27	36.0	162	54.0	98	32.7						
Gabbro	2	2.7	8	2.7	8	2.7						
Diorite	3	4.0	22	7.3	20	6.7						
Schist 1	2	2.7			4	1.3						
Schist 2	2	2.7	4	1.3								
Clay	4	5.3	24	8.0	8	2.7						
Quartz					26	8.7						
Feldspar					30	10.0						
Volcaniclastic					4	1.3						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Felsic Tuff 1	Subangular	Fresh	Grey	Hard, lithic fragments
Felsic Tuff 2	Subangular	Slightly wx	Grey	Hard
Rhyolite	Subround	Fresh	Buff	Dense
Granite 1	Subangular	Fresh	White	Hard, medium grained
Granite 2	Subangular	Slightly wx	Brown	Hard
Mafic Volcanic	Subround	Dense	Black	Dense
Gabbro	Subangular	Fresh	Grey	Hard, medium grained
Diorite	Subangular	Fresh	Green	Hard
Schist 1	Subround	Fresh	Grey	Hard
Schist 2	Angular	Mod. wx	Grey	Friable,earthy,potent. deleterious
Clay	Subround			Earthy, soft, potent. deleterious
Quartz	Angular	Fresh	White	Dense
Feldspar	Angualr	Fresh	Pink	Hard
Volcaniclastic	Subround	Very wx	Brown	Earthy, potentially deleterious

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 85-3161 LOCATION: Black River Point TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	B 10%		C 4%		G 10%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Mafic Volc. 1	16	5.3	26	8.7	15	5.0						
Mafic Volc. 2	-	-	2	0.7	-	-						
Rhyolite	12	4.0	22	7.4	21	7.0						
Granite 1	196	65.3	144	48.0	63	21.0						
Granite 2	2	0.7	2	0.7	-	-						
Quartz	-	-	3	1.0	81	27.0						
Basalt	44	14.6	55	18.1	63	21.0						
Diorite	4	1.4	22	7.3	45	15.0						
Sandstone	20	6.7	16	5.3	9	3.0						
Siltstone	4	1.3	7	2.3	3	1.0						
Schist	2	0.7	1	0.3	-	-						
TOTALS	300		300		300							

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Mafic Volc. 1	Subround	Fresh	Green	Abundant lithic fragments
Mafic Volc. 2	Subround	Slightly wx	Green	Hard
Rhyolite	Subround	Fresh	Brown	Hard occasional porphyritic
ranite 1	Angular	Fresh	Pink	Hard
Granite 2	Angular	Slightly wx	Pink	Minor epidote
Quartz	Angular	Fresh	White	Hard, medium grained
Basalt	Round	Fresh	Green	Hard amygdaloidal
Diorite	Subangular	Fresh	Green	Hard
Sandstone	Angular	Fresh	Red	Hard
Siltstone	Subround	Fresh	Green	Hard
Schist	Subround	Fresh	Grey	Moderate wx

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6001 LOCATION: Holyrood TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 50%		B 10%		C 22%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Granite 1	172	57.3	123	41.0	126	42.0						
Granite 2	-	-	-	-	3	1.0						
Sandstone 1	92	30.7	90	30.0	105	35.0						
Sandstone 2	4	1.3	9	3.0	6	2.0						
Siltstone 1	32	10.7	66	22.0	54	18.0						
Siltstone 2	-	-	12	4.0	6	2.0						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Granite 1	Subangular	Fresh	Grey	Hard
Granite 2	Angular	Slightly wx	Grey	Hard
Sandstone 1	Subround	Fresh	Brown	Hard
Sandstone 1	Subround	Slightly wx	Brown	Hard
Siltstone 1	Round	Fresh	Red	Hard, Dense
Siltstone 2	Round	Fresh	Brown	Hard, Clay coating

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6002 LOCATION: Port aux Basques TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 38%		B 19%		C 10%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Sandstone 1	56	18.7	51	17.0	58	19.3						
Sandstone 2			3	1.0	2	0.8						
Granite 1	52	17.3	75	25.0	72	24.0						
Granite 2	8	2.7										
Granodiorite 1	164	54.7	147	49.0	150	50.0						
Granodiorite 2					2	0.8						
Gabbro	4	1.3	3	1.0								
Diorite	16	5.3	21	7.0	8	2.6						
Quartz					2	0.8						
Schist					2	0.8						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Sandstone 1	Subround	Fresh	Grey	Occ. schistose texture
Sandstone 2	Subround	Slightly wx	Grey	Hard
Granite 1	Angular	Fresh	Grey	Hard, medium grained
Granite 2	Angular	Slightly wx	Grey	Hard
Granodiorite 1	Angular	Fresh	Grey	Hard, medium grained
Granodiorite 2	Angular	Slightly wx	Grey	Hard
Gabbro	Angular	Fresh	Grey	Hard, medium grained
Diorite	Subangular	Fresh	Green	Hard
Quartz	Subround	Fresh	White	Fine grained
Schist	Subround	Fresh	Grey	Hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6003 LOCATION: Stephenville TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	C 36%		D 50%									
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Granite 1	15	5	16	5.4								
Granite 2	6	2	6	2.0								
Quartzite 1	83	27.7	86	29.1								
Quartzite 2	8	2.7	12	4.1								
Granodiorite	47	15.7	116	37.8								
Diorite	121	40.3	62	20.9								
Diorite	10	3.3										
Rhyolite	10	3.3										
Schist			2	0.6								
TOTALS	300	100	300	100								

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Granite 1	Angular	Fresh	White	Hard, medium grained
Granite 2	Angular	Slightly wx	Grey	Hard
Quartzite 1	Subangular	Fresh	Grey	Hard, medium grained
Quartzite 2	Subangular	Slightly wx	Grey	Hard, clay coating
Granodiorite	Subangular	Fresh	Grey	Hard
Diorite	Subround	Fresh	Green	Hard
Diorite	Subround	Fresh	Green	Abundant olivine, coarse grained
Rhyolite	Subround	Fresh	Buff	Dense
Schist	Subround	Fresh	Grey	Hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6004 LOCATION: St. Anthony TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 10%		B 16%		CD 28%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Limestone 1	264	88.0	282	94.0	237	79.0						
Limestone 2	12	4.0	15	5.0	36	12.0						
Dolomite	16	5.4			9	3.0						
Granite	4	1.3	3	1.0	6	2.0						
Gneiss	4	1.3										
Sandstone					3	1.0						
Shale					9	3.0						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Limestone 1	Subangular	Fresh	Grey	Dense, hard
Limestone 2	Subround	Slightly wx	Buff	Slightly argillaceous, mod. hard
Dolomite	Subround	Fresh	Grey	Microcrystalline, hard
Granite	Angular	Fresh	Grey	Hard
Gneiss	Angular	Fresh	Grey	Hard, medium grained
Sandstone	Subround	Fresh	Red	Hard
Shale	Subround	Fresh	Black	Hard, potentially deleterious

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6005 LOCATION: Stephenville TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	C 5%		D 16%		E 20%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Granite 1	63	21.0	54	18.0	48	16.0						
Granite 2			9	3.0	7	2.3						
Rhyolite	33	11.0	21	7.0	16	5.3						
Mafic Volc. 1	78	26.0	81	27.0	87	29.0						
Mafic Volc. 2	12	4.0	15	5.0	11	3.7						
Quartzite	6	2.0	12	4.0	3	1.0						
Basalt	60	20.0	75	25.0	91	30.3						
Gabbro	18	6.0	18	6.0	20	6.7						
Diorite	21	7.0	6	2.0	5	2.0						
Schist	9	3.0	9	3.0	6	2.0						
Kspar					6	2.0						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Granite 1	Angular	Fresh	Grey	Hard, medium grained
Granite 2	Subangular	Slightly wx	Grey	Hard
Rhyolite	Subround	Fresh	Buff	Dense, hard
Mafic Volcanic	Subangular	Fresh	Grey	Hard, tuffaceous
Mafic Volcanic	Subangular	Slightly wx	Brown	Hard
Quartzite	Angular	Fresh	White	Hard
Basalt	Subround	Fresh	Grey	Dense
Gabbro	Subangular	Fresh	[illegible]	Hard, coarse grained
Diorite	Subangular	Fresh	G[illegible]	H[illegible], coarse grained
Schist	Subround	Fresh	Grey	Fairly hard
Kspar	Angular	Fresh	Pink	Hard, dense

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6006 LOCATION: Gallants TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	C 9%		D 11%		E 31%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Granite	117	39.0	81	27.0	90	30.0						
Rhyolite	6	2.0	15	5.0	15	5.0						
Diorite 1	123	41.0	102	34.0	117	39.0						
Diorite 2	24	8.0	3	1.0								
Felsic Volc.	15	5.0	27	9.0	33	11.0						
Quartzite	9	3.0	63	21.0	33	11.0						
Sandstone	3	1.0	6	2.0	3	1.0						
Schist	3	1.0	3	1.0	9	3.0						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Granite	Angular	Fresh	Grey	Medium grained, hard
Rhyolite	Subround	Fresh	Grey	Hard, dense
Diorite	Subangular	Fresh	Green	Hard
Diorite	Subangular	Fresh	Green	Abundant olivine
Fersic Volc.	Round	Fresh	Grey	Dense, hard
Quartzite	Subround	Moderate wx	Brown	Fe staining, fine grained
Sandstone	Subround	Fresh	Brown	Hard
Schist	Subangular	Moderate wx	Brown	Friable, potentially deleterous

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6007 LOCATION: Springdale TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 51%		B 27%		C 10%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Tuff.Sandst. 1	2	4.0	40	13.3	40	13.3						
Tuff.Sandst. 2	1	2.0	4	1.3	4	1.4						
Rhyolite 1	8	16.0	36	12.0	46	15.3						
Rhyolite 2			2	0.7	4	1.4						
Granite	18	36.0	92	30.7	88	29.3						
Quartz Monzon.	3	6.0	24	8.0	18	6.0						
Basalt	3	6.0	34	11.3	24	8.0						
Diorite	10	20.0	36	12.0	34	11.0						
Sandstone	1	2.0	10	3.3	6	2.0						
Oliv. Diabase	3	6.0	10	3.3	2	0.7						
Schist	1	2.0										
Gabbro			2	0.7	8	2.7						
Quartzite			10	3.3	22	7.3						
Siltstone					4	1.4						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Tuff.Sandst. 1	Subround	Fresh	Grey	Abundant lithic fragments.
Tuff.Sandst. 2	Subround	Slightly wx	Grey	Hard
Rhyolite 1	Subround	Fresh	Buff	Porphyritic
Rhyolite 2	Subangular	Slightly wx	Brown	Hard, clay coating
Granite	Subangular	Fresh	Grey	Hard, medium grained
Quartz Monzon.	Subangular	Fresh	White	Hard, medium grained
Basalt	Subround	Fresh	Grey	Porphyritic, hard
Diorite	Subround	Fresh	Green	Hard
Sandstone	Round	Fresh	Red	Hard
Oliv. Diabase	Subround	Fresh	Green	Abundant olivine
Schist	Subround	Fresh	Grey	Hard
Gabbro	Subangular	Fresh	Grey	Hard
Quartzite	Subround	Fresh	Grey	Hard, coarse grained
Siltstone	Round	Fresh	Red	Hard, dense

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6008 LOCATION: Grand Falls TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 13%		B 40%		CD 39%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Felsic Volc. 1	76	25.3	24	8.0	21	7.0						
Felsic Volc. 2	6	2.0	4	1.4								
Rhyolite 1	28	9.3	4	1.4	35	11.7						
Basalt	50	16.7	46	15.3	41	13.7						
Sandstone	68	22.7	106	35.3	90	30.0						
Siltstone	62	20.7	100	33.3	72	24.0						
Quartz Monz.	4	1.3	16	5.3	13	4.3						
Conglomerate	2	0.7										
Gabbro	4	1.3										
Diorite					25	8.3						
Rhyolite 2					2	0.7						
Quartz					1	0.3						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Felsic Volc. 1	Subround	Fresh	Grey	Hard, dense, lithic fragments
Felsic Volc. 2	Subangular	Slightly wx	Grey	Hard
Rhyolite 1	Subround	Fresh	Buff	Hard, dense
Basalt	Subround	Fresh	Grey	Hard, dense
Sandstone	Subround	Fresh	Red	Hard
Siltstone	Subround	Fresh	Grey	Dense
Quartz Monz.	Subangular	Fresh	Grey	Medium grained, hard
Conglomerate	Subround	Fresh	Brown	Hard
Gabbro	Subangular	Fresh	Grey	Hard
Diorite	Subround	Fresh	Green	Hard
Rhyolite 2	Subangular	Slightly wx	Brown	Hard
Quartz	Angular	Fresh	White	Medium grained, hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6089 LOCATION: Lewisporte TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 8%		BC 67%		D 22%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Granodiorite 1	252	84.0	114	38.0	60	20.0						
Granodiorite 2	6	2.0	-	-	-	-						
Sandstone	33	11.0	48	16.0	45	15.0						
Quartz	3	1.0	3	1.0	-	-						
Basalt	3	1.0	6	2.0	12	4.0						
Rhyolite	3	1.0	12	4.0	30	10.0						
Volcaniclastic	-	-	6	2.0	-	-						
Gabbro	-	-	33	11.0	12	4.0						
Diorite	-	-	78	26.0	129	43.0						
Siltstone	-	-	-	-	12	4.0						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Granodiorite 1	Subangular	Fresh	Grey	Hard, medium grained
Granodiorite 2	Subangular	Slightly wx	Grey	Hard
Sandstone	Subround	Fresh	Brown	Hard
Quartz	Angular	Fresh	White	Hard, dense
Balsalt	Subround	Fresh	Black	Hard, dense
Rhyolite	Round	Fresh	Buff	Hard, dense
Volcaniclastic	Subround	Fresh	Green	Hard
Gabbro	Subangular	Fresh	Grey	Hard, medium grained
Diorite	Subangular	Fresh	Brown	Hard, dense

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6090 LOCATION: Butt's Pond (Gander) TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 30%		D 10%		E 12%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Granite	168	56.0	66	22.0	73	24.3						
Granodiorite	67	22.3	28	9.3	42	14.0						
Schist 1	65	21.6	186	62.0	154	51.3						
Schist 2	-	-	6	2.0	7	2.3						
Quartzite	-	-	14	4.7	21	7.0						
Kspar	-	-	-	-	3	1.0						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Granite	Subangular	Fresh	Grey	Hard, medium grained
Granodiorite	Subangular	Fresh	Grey	Hard, medium grained
Schist 1	Subround	Fresh	Buff	Medium hard
Schist 2	Subround	Slightly wx	Buff	Slightly friable, pot. deleterous
Quartzite	Angular	Fresh	White	Hard, coarse grained
Kspar	Angular	Fresh	Pink	Hard, dense

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6091 LOCATION: Eastport TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 15%		D 30%									
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Granite	156	52.0	120	40.0								
Volcaniclastic	12	4.0	6	2.0								
Quartzite	4	1.3	-	-								
Basalt	20	6.7	-	-								
Sandstone	28	9.3	45	15.0								
Siltstone	12	4.0	39	13.0								
Schist	64	21.4	84	28.0								
Gneiss	4	1.3	6	2.0								
TOTALS	300	100	300	100								

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Granite	Subangular	Fresh	Grey	Hard, medium grained
Volcaniclastic	Subround	Fresh	Grey	Hard
Quartzite	Subround	Fresh	White	Hard, medium grained
Basalt	Subround	Fresh	Grey	Med. hard, dense
Sandstone	Subround	Fresh	Red	Hard
Siltstone	Subround	Fresh	Red	Dense
Schist	Subangular	Fresh	Grey	Med. hard
Gneiss	Angular	Fresh	Grey	Coarse grained

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6093 LOCATION: Goose Bay TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	C 5%		D 8%		F 20%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Granite 1	120	40.0	34	11.3	12	4.0						
Granite 2	12	4.0	8	2.7	2	0.7						
Rhyolite	6	2.0	2	0.7	-	-						
Quartzite	6	2.0	6	2.0	56	18.7						
Basalt	6	2.0	-	-	-	-						
Diorite	24	8.0	4	1.3	2	0.7						
Gneiss 1	90	30.0	200	66.7	176	58.7						
Gneiss 2	36	12.0	46	15.3	28	9.3						
Garnet	-	-	-	-	4	1.3						
Feldspar	-	-	-	-	8	2.7						
Hornblende	-	-	-	-	12	4.0						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Granite 1	Subangular	Fresh	Pink	Equigranular, hard
Granite 2	Subangular	Slightly wx	Grey	Sericitized, hard
Rhyolite	Subround	Fresh	Brown	Dense
Quartzite	Subround	Fresh	White	Hard
Basalt	Subround	Fresh	Grey	Dense
Diorite	Round	Fresh	Green	Hard
Gneiss 1	Subangular	Fresh	Grey	Occasional garnets, hard
Gneiss 2	Subangular	Moderate. wx	Brown	Coarse grain.,friable,potent.delet
Garnet	Round	Fresh	Red	Hard
Feldspar	Angular	Fresh	Pink	Hard, dense
Hornblende	Angular	Fresh	Green	Med. hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6094 LOCATION: Marystown TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 5%		B 40%		CD 49%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Felsic Volc. 1	156	52.0	194	64.7	160	53.3						
Felsic Volc. 2	3	1.0	8	2.7	6	2.0						
Rhyolite	102	34.0	76	25.3	94	31.2						
Granite	30	10.0	8	2.7	2	0.7						
Basalt	9	3.0	10	3.2	30	10.0						
Gabbro	-	-	-	-	2	0.7						
Diorite	-	-	2	0.7	2	0.7						
Sandstone	-	-	2	0.7	2	0.7						
Quartz	-	-	-	-	2	0.7						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Felsic Volc. 1	Subangular	Fresh	Brown	Lithic fragments, hard
Felsic Volc. 2	Subangular	Slightly wx	Brown	Hard
Rhyolite	Subround	Fresh	Rust	Dense, hard
Granite	Subround	Fresh	Pink	Equigranular, hard
Basalt	Subround	Fresh	Grey	Amygdaloidal, dense
Gabbro	Subangular	Slightly wx	Grey	Hard
Diorite	Angular	Fresh	Green	Abundant olivine
Sandstone	Subangular	Fresh	Brown	Hard
Quartz	Subangular	Fresh	Clear	Dense

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6095 LOCATION: Clarenville TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 12%		B 47%		CD 40%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Tuff.Sandst. 1	129	43.0	106	35.3	84	2.8						
Tuff.Sandst. 2	3	1.0	8	2.7	3	1.0						
Rhyolite 1	12	4.0	20	6.7	18	6.0						
Rhyolite 2	3	1.0	-	-	-	-						
Granite 1	18	6.0	68	22.7	84	28.0						
Granite 2	3	1.0	6	2.0	-	-						
Gabbro	15	5.0	8	2.7	10	3.3						
Diorite	60	20.0	28	9.3	32	10.7						
Sandstone	33	11.0	22	7.3	39	13.0						
Siltstone	12	4.0	14	4.7	18	6.0						
Gneiss	6	2.0	8	2.7	1	0.3						
Schist	3	1.0	-	-	5	1.7						
Syenite	3	1.0	8	2.7	1	0.3						
Basalt	-	-	2	0.6	4	1.4						
Quartz	-	-	2	0.6	1	0.3						
TOTALS	300	100	300	100	300	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Tuff.Sandst. 1	Subangular	Fresh	Green	Lithic fragments, hard
Tuff.Sandst. 2	Subangular	Slightly wx	Green	Hard, clay coating
Rhyolite 1	Subangular	Fresh	Buff	Porphyritic plagioclase, dense
Rhyolite 2	Subrounded	Sl.weathered	Buff	Hard
Granite 1	Subangular	Fresh	Grey	Hard, equigranular
Granite 2	Angular	Sl.weathered	Grey	Firm, slightly sericitized
Gabbro	Angular	Fresh	Grey	Hard
Diorite	Angular	Fresh	Grey	Firm, equigranular
Sandstone	Subround	Fresh	Purple	Hard, equigranular
Siltstone	Subround	Fresh	Grey	Hard, dense
Gneiss	Round	Fresh	Grey	Hard
Schist	Subround	Fresh	H. Green	Hard
Syenite	Subround	Fresh	Grey	Hard
Basalt	Subangular	Fresh	Black	Occ. amygdaloidal, dense
Quartz	Angular	Fresh	White	Medium grained

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 86-6096 LOCATION: Wabush TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	B 38%		D 24%		E 5%		F 2%					
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Quartzite 1	95	63.3	113	75.3	154	51.3	100	33.3				
Quartzite 2	52	34.7	29	19.4	88	29.3	106	35.3				
Schist	3	2.0	6	4.0	14	4.7	12	4.0				
Quartz	-	-	-	-	44	14.7	82	27.4				
Hornblende	-	-	2	1.3	-	-	-	-				
TOTALS	150	100	150	100	300	100	300	100				

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Quartzite	Angular	Fresh	White	FeO staining, hard
Quartzite	Angular	Medium wx	White	Mica rich firm,potent. deleterious
Schist	Subround	Fresh	Grey	Med. hard
Quartz	Subround	Fresh	White	Hard
Hornblende	Subangular	Fresh	Green	Med. hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 88 GA01 LOCATION: Seal Cove TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 10%		B 30%		C 30%		D 10%					
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Granite	17	34	69	46	123	41	157	52				
Leucogranite	16	32	26	17	72	24	48	16				
Sandstone	13	26	18	12	18	6	19	6				
Siltstone			9	6	9	3	13	4				
Mafic Volcanic	4	8	10	7	36	12	48	16				
Diabase			8	5	3	1						
Rhyolite			10	7	39	13	15	5				
Quartz												
TOTALS	50	100	150	100	300	100	300	100	150	100		

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Granite	Angular	Fresh	Pink	Hard, medium grained
Leucogranite	Angular	Fresh	Light Grey	Hard
Sandstone	Subangular	Md. wx	Grey	Med. hard
Siltstone	Subrounded	Fresh	Light Grey	Hard
Mafic Volcanic	Subrounded	Md. wx	Green/Grey	Mod. hard, fine grained
Diabase	Subangular	Fresh	Grey	Hard
Rhyolite	Angular	Fresh	Pink	Hard, dense
Quartz	Angular	Fresh	White	Hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 88 GA02 LOCATION: Lundrigans TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 10%		B 20%		CD 35%		E10%					
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Sandstone	88	88	82	82	83	83	92	92				
Siltstone	12	12	18	18	17	17	8	8				
TOTALS	100	100	100	100	100	100	100	100	100	100		

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Sandstone	Angular	Fresh	green/grey	Hard, clay coated
Siltstone	Angular	Fresh	grey	Hard, concoidal fract.,clay coated

7

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 88 GA03 LOCATION: Mackisons TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	19mm		12.7mm		4.75mm							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Siltstone	64	64	59	59	62	62						
Sandstone	36	36	41	41	38	38						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Siltstone	Subangular	Unweathered	grey	hard
Sandstone	Subangular	Unweathered	grey	hard

Golder Associates

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 88 GA03 LOCATION: Mackisons TYPE: Coarse & Fine

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 10%		B 25%		CD 40%		E 25%					
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Siltstone	72	72	67	67	64	64	59	59				
Sandstone	28	28	33	33	36	36	41	41				
TOTALS	100	100	100	100	100	100	100	100	100	100		

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Siltstone	Subangular	Fresh	grey	hard
Sandstone	Subangular	Fresh	grey	hard

PARTICLE COUNT METHOD (ASTM C 295)

SAMPLE NO.: 88 GA04 LOCATION: Pipers Hole TYPE: Coarse

LITHOLOGICAL PROPORTIONS

CONSTITUENTS	A 21%		B 32%		CD 41%							
	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%	PART.	%
Felsic Tuff	23	15	35	23	35	23						
Rhyolite	26	17	23	15	27	18						
Granite	21	14	15	10	13	9						
Mafic Volcanic	17	11	6	4	11	7						
Sandstone	49	33	60	40	48	32						
Diorite	14	10	11	8	16	11						
TOTALS	150	100	150	100	150	100						

LITHOLOGICAL DESCRIPTIONS

CONSTITUENTS	PARTICLE SHAPE	PARTICLE CONDITION	COLOR	COMMENTS
Felsic Tuff	subangular	Fresh	green/grey	Hard
Rhyolite	subrounded	Fresh	pink	Hard
Granite	subrounded	Fresh	pink	Hard
Mafic Volcanic	subangular	Fresh	green	Med. hard
Sandstone	subangular	Fresh	grey	Hard
Diorite	subrounded	Fresh	grey	Mod. hard

APPENDIX C2

THIN SECTION ANALYSIS

SECTION I

LOCATION	SAMPLE NO.
SWIFT CURRENT	85-3017-C
SWIFT CURRENT	85-3032-C
SWIFT CURRENT	85-3058-C
SWIFT CURRENT	85-3058-F
PIPER'S HOLE	85-3066-C
PIPER'S HOLE	85-3066-F
WABUSH	85-6096-C
WABUSH	85-6096-F
ADAM'S HEAD	85-6213
ST. ANTHONY	86-6004-F
HOLYROOD	86-6006-F
GANDER	86-6090-C
GANDER	86-6090-F
GOOSE BAY	86-6093-C

F. Mengel - June 1987

7

Sample No.: **85-3017-C**
Location: **SWIFT CURRENT**

FRAGMENT 1

Rocktype: Chloritized volcanic rock (basic)

Description:
The matrix is totally replaced by chlorite and minor opaques. Original phenocrysts are replaced by muscovite, but their outlines are preserved. Epidote (product of plagioclase replacement) is a common constituent.

FRAGMENT 2

Rocktype: Hematite?-impregnated volcanic rock

Description:
Plagioclase laths (0.1 mm) occur in a opaque dominated matrix, probably the result of post emplacemnt impregnation. Some of the larger plagioclase grains are partly replaced by epidote.

FRAGMENT 3

Rocktype: Altered felsic volcanic rock

Description:
This rock is quartz rich, and has a planar fabric defined by parallel orientation of muscovite laths. Chlorite is not observed, suggesting felsic/acid rather than basic composition. Opaques constitute ca. 5 vol%.

Comments:
Fragment 1 is an altered basaltic volcanic rock which is now composed almost entirely of chlorite. This fragment represents a lithology which is chemically and physically unstable. Fragment 2 is hematite rich and potentially deleterious because of the common association of hematite rich sediments with jasper and chert. Fragment 3 is a silica rich altered felsic volcanic rock, and thus chemically deleterious. In summary, an aggregate composed of lithologies similar to the ones represented above, may be chemically as well as physically unstable.

Sample No.: **85-3032-C**
Location: **SWIFT CURRENT**

FRAGMENT 1

Rocktype: Brecciated basic volcanic rock

Description:
This is a brecciated volcanic rock containing fragments of several different types of basic volcanics. The fragments all contain phenocrysts in a dark aphanitic matrix and can be distinguished by the amount and shape/size of the plagioclase laths. A few fragments contain quartz filled vesicles, and probably represent more tuffaceous facies. Plagioclases in volcanic fragments are variably sericitized, and often partly replaced by epidote.

FRAGMENT 2

Rocktype: Felsic volcanic rock

Description:
This volcanic rock is dominantly composed of very finegrained recrystallized quartz. Epidote is common, and suggest that plagioclase was an important primary phase. Finegrained zones in the rock truncate quartz aggregates, and may represent original flow bands, or may be the result of superimposed deformation.

FRAGMENT 3

Rocktype: Felsic volcanic rock

Description:
This rock contains angular quartz and feldspar phenocrysts in a quartz rich matrix. Feldspars are variably altered to muscovite, or, less commonly, chlorite aggregates.

FRAGMENT 4

Rocktype: Felsic volcanic rock

Description:
Thoroughly recrystallized finegrained quartz and feldspar aggregates dominate this rock, which also contains ca. 25 vol% epidote.

Comments:
Fragment 1 is a strongly altered basaltic volcanic rock, whereas fragments 2, 3, and 4 are variably altered felsic volcanic rocks. The latter may be chemically unstable, as the high silica content renders the deleterious alkali-silica reaction possible. In summary: aggregate composed of the above lithologies may be unsuitable for concrete.

Sample No.: 85-3058-C
Location: SWIFT CURRENT

FRAGMENT 1

Rocktype: Chloritized volcanic rock (basic)

Description:
Chlorite is the dominant constituent in this altered basic volcanic rock, where the outline of plagioclase phenocrysts has been preserved, although plagioclase is replaced by epidote (ca. 5-10 vol%), muscovite, and quartz. Sphene and opaques are accessory phases. No penetrative fabric is apparent in this rock.

FRAGMENT 2

Rocktype: Volcanic rock (basic)

Description:
This rock is similar to, but less altered than, fragment 1. Finegrained plagiclase phenocrysts (25-30 vol%) are preserved, whereas the remainder of the matrix is altered to chlorite.

FRAGMENT 3

Rocktype: Volcanic (basic) rock

Description:
This volcanic rock represents a flow different from fragments 1 and 2, judging by the size/shape/amount of plagioclase phenocrysts. Laths are larger (up to 0.5 mm) but are totally replaced by finegrained aggregates of epidote and minor muscovite. Larger recrystallized aggregates of epidote occur as well. Penninitic chlorite (deep blue) occur in ground inclusions. Quartz is a minor component.

FRAGMENT 4

Rocktype: Quartz-rich sedimentary rock

Description:
Bedding in this sediment is defined by grading and opaque-rich layers. Oblique to bedding, a cleavage, defined by aligment of micas and opaques, is developed. Quartz is recrystallized, no clastic grains appear to be preserved. Muscovite and chlorite comprise less than 10 vol%.

FRAGMENT 5

Rocktype: Quartzite

Description:
This fragment is composed intirely of quartz, displaying a varied grain size, and showing varying degrees of recrystallization.

Comments:
Fragments 1, 2, and 3 are variably altered basaltic volcanic rocks, and Fragments 4 and 5 are both quartz rich sediments. Any of these components may cause problems when used in concrete.

Sample No.: **85-3058-F**
Location: **SWIFT CURRENT**

FRAGMENT 1

Rocktype: Mylonitized mica-schist

Description:
This rock is finegrained and display a well-developed planar fabric defined by muscovite (50-60 vol%). Chlorite (ca. 10 vol%), replacing muscovite?, occur with muscovite throughout. The mylonitic fabric wraps around strongly strained quartz porphyroclasts (up to 1 mm).

FRAGMENT 2 (TOO SMALL/THICK TO DESCRIBE)

FRAGMENT 3

Rocktype: Altered volcanic (basic) rock

Description:
The matrix of this altered volcanic rock is made up of finegrained chlorite and muscovite (ca. 95 vol%). Other minerals are epidote (2 vol%), opaques (<5 vol%), and accessory quartz.

FRAGMENT 4

Rocktype: Volcanic rock (basic)

Description:
This sample is similar to fragment 1 in sample 3066F, and is made up of ca. 80 vol% small plagioclase phenocrysts in a matrix of epidote (< 10 vol%) and chlorite and opaques (5-10 vol%). This rock is a moderately altered volcanic flow.

FRAGMENT 5

Rocktype: Tectonized volcanic rock (basic)

Description:
This finegrained altered volcanic rock is dominated by chlorite-quartz aggregates and comprise minor epidote (<10 vol%) and muscovite (accessory). Fe-oxide staining (hematite?) occurs throughout.

FRAGMENT 6

Rocktype: Altered volcanic rock (probably felsic)

Description:
This rock is characterized by angular quartz fragments occurring in a quartz-chlorite-muscovite matrix. Opaques are reddish (hematite?). The angular quartz fragments probably represent relict phenocrysts in an acid volcanic rock (primary feldspar phenocrysts are altered to micas).

Comments:
Fragment 1 is strained and rich in quartz (>25 vol%) and hydrous layer silicates. Fragments 3, 4, and 5 are variably altered basaltic volcanic rocks. The highly altered ones contain ca. 10 vol% H2O (bound in chlorite), whereas the less altered ones potentially may hydrate (and expand) if used in concrete. Fragment 6 is an altered felsic (quartz rich) volcanic rock, and probably chemically deleterious. In summary, an aggregate composed of the above fragments may be chemically and physically unsuitable for use in concrete.

Sample No.: **85-3066-C**
Location: **PIPER'S HOLE**

Rockname: Greenschist (metamorphosed basic volcanic rock)

Description:
Chlorite is the dominant mineral in this finegrained greenschist (ca. 80 vol%) and defines the gently folded planar fabric. Quartz makes up ca. 5-10 vol% and biotite, muscovite, opaques, and sphene are accessory phases. Low grade colorless amphiboles (actinolite) may be present, but could not be identified with certainty.

Comments:
The high content of layer silicates (ca. 80 vol% chlorite) makes the rock friable and brittle, and since chlorite contains ca. 10-13% H2O (by volume) the rock will contain ca. 10% H2O.

Sample No.: **85-3066-F**
Location: **PIPER'S HOLE**

FRAGMENT 1

Rocktype: Basic volcanic rock (flow)

Description:
Small (0.1-0.5 mm) plagioclase laths dominate this specimen (ca. 75 vol%). They occur in a dark generally aphanitic matrix in which only small epidote grains can be recognized. Larger muscovite aggregates probably represent altered plagioclase grains or lithic fragments.

FRAGMENT 2

Rocktype: Hematite?-impregnated quartz-rich sediment

Description:
The matrix of this rock (ca. 90 vol%) is opaque with a reddish tinge, and is probably composed of hematite. Quartz and muscovite grains with preferred shape orientation define a planar fabric.

FRAGMENT 3

Rocktype: Arkosic sediment

Description:
Angular to round quartz fragments comprise ca. 50 vol% of this sample, and are, along with variably sericitized and recrystallized feldspar grains, the dominant phases. Epidote constitute ca. 5 vol%, and tourmaline and muscovite are accessory minerals.

Comments:
Fragment 1 is chemically and physically stable if hydration can be avoided. In case of hydration (conversion of mafic igneous minerals to e.g. chlorite) at least 10% H2O will be "added" to the rock, and significant expansion will occur. Fragment 2 is hematite rich, and should probably be avoided, partly because of its chemical instability, partly because of the common association of hematite rich sediments with jasper (chert) beds. Fragment 3 contains ca. 50 vol% quartz and is thus a good candidate for deleterious alkali-silica reactions. In summary, an aggregate composed of the above fragments may give problems if used in concrete.

7

Sample No.: **85-6096 C**
Location: **WABUSH**

FRAGMENT 1

Rocktype: Tonalitic gneiss

Description:
This is a medium to coarse grained (0.5 to 2.0 mm) tonalitic gneiss in amphibolite or granulite facies. Plagioclase (30-40 vol%) and quartz (20-25 vol%) are the dominant minerals. Plagioclase is only mildly sericitized and locally altered to epidote. Clinopyroxene (<2 vol%) commonly have thin alteration rims of green amphibole. Biotite (<5 vol%) often has saginitic microstructure, suggesting replacement from hornblende. Hornblende occurs, but comprise less than 1 vol%.

FRAGMENT 2

Rocktype: Quartzite

Description:
This rock consist of recrystallized quartz, and display an incipient Fe-oxide coating, migrating inwards from the rim of the fragment.

FRAGMENT 3

Rocktype: Altered biotite granite

Description:
Quartz, plagioclase, and K-feldspar make up the bulk of this rock (ca. 90 vol%); feldspars are variably sericitized. Biotite 5-10 vol%) is partly replaced by chlorite, and accessory epidote occurs.

FRAGMENT 4:

Rocktype: Granite

Description:
This is a coarse grained (1-2 mm) granite consisting of quartz, plagioclase, and K-feldspar in approximately equal proportions. Plagioclase is variably altered; ca. 5-10% are converted to sericite.

Comments:
All fragments contain at least 30 vol% quartz and must thus be considered potentially chemically deleterious.

Sample No.: **85-6096-F**
Location: **WABUSH**

Rocktype: Granitic rock

Description:
This slide contains several fragments of the same rocktype. Quartz, plagioclase, and K-feldspar occur in approximately equal proportions, with K-feldspar generally appearing between large quartz and plagioclase grains. Biotite is often found at rims of rock fragments, suggesting formation via replacement inward from the rim. Plagioclase is mildly (less than 10%) sericitized. Quartz grains are slightly strained. Accessory minerals are epidote, muscovite, and calcite.

Comments:
All fragments from this sample contain at least 30 vol% quartz, which is often strained. Deleterious alkali-silica reactions are possible.

Sample no.: 85-6213
Location: **ADAM'S HEAD**

Rocktype: Sedimentary (arkose)

Description:
Quartz and feldspar occur in 0.1-0.3 mm angular fragments and constitute ca. 75 vol%. Quartz grains are generally unstrained and most feldspar grains are variably sericitized. A brownish dusting (probably Fe-oxides) typically occur in the feldspars. Green chlorite makes up a large part of the matrix, along with accessory amounts of zircon, tourmaline, epidote, and opaques. Calcite grains make up ca. 2 vol%, and a few rock fragments of volcanic origin can be recognized.

Comments:
The high quartz content (more than 25 vol%) may makes an aggregate composed of the above lithology unsuitable for use in concrete. In addition, the sericitization of feldspars have increased the volume of deleterious components (layer silicates).

Sample no.: 86-6004-F
Location: ST. ANTHONY

FRAGMENT 1

Rocktype: Probably of basic volcanic origin

Description:
This fragment is extremely homogeneous and finegrained and individual minerals cannot be identified. However, the distinct greenish color is similar to strongly chloritized basic volcanics, hence it is believed that this sample is very chlorite rich. Small bright laths seem to define a weak planar fabric; these may be muscovite grains.

FRAGMENT 2

Rocktype: Probably of volcanic origin

Description:
This rock fragment is very fine grained and is faintly greenish in plane polarized light. This suggest the presence of chlorite, although the modal % is difficult to judge (probably less than 25%). Finegrained quartz aggregates dominate the rock, suggesting that this is either a felsic (acid) volcanic rock or a silicified basic volcanic rock. The latter is supported by the presence of several veins of recrystallized quartz. Calcite and opaques occur in accessory amounts.

FRAGMENT 3

Rocktype: Probably of basic volcanic origin

Description:
Similar to fragments 1 and 2, this one is very finegrained and individual mineral constituents cannot be identified with the petrographic microscope. However, the greenish color suggest that chlorite is a dominant phase. Quartz veins and round quartz-aggregates (probably filled vesicles) suggest that minor silicification affected the rock. A linear opaque seam (ca. 0.05 mm wide) occur in the fragment.

FRAGMENT 4

Rocktype: Altered volcanic rock

Description:
Matrix in this finegrained irregular volcanic rocks is brownish and contain small angular fragments of recrystallized finegrained quartz. Matrix is clearly mica rich, and muscovite and chlorite can be recognized. The presence of quartz veins and larger recrystallized quartz aggregates suggest that this volcanic rock has been severely altered (silicification, hydration).

Comments:
Fragments 1, 3, and 4 are variably altered basaltic volcanics. Unaltered parts of the rocks may undergo hydration (and thus: expansion) if used for concrete, and are hence not considered suitable. Fragment 2 is an altered felsic (silica-rich) volcanic rock, which may be deleterious in concrete.

Sample no.: 86-6006-F
Location: HOLYROOD

FRAGMENT 1

Rocktype: Metasediment?

Description:
Irregular biotite grains (grain size 0.1-0.5 mm) make up more than half of this specimen, and are frequently deformed and kinked. Quartz occurs in very finegrained recrystallized aggregates, while chlorite (altered from biotite) and muscovite are accessory phases.

FRAGMENT 2

Rocktype: Quartzite (Quartz-rich part of schist)

Description:
Recrystallized quartz makes up >95 vol% of this rock, and minor amounts of mica define a weak planar fabric.

FRAGMENTS 3 AND 4

Rocktype: Metasediment?

Description:
Feldspar occur in coarse aggregates (2-3 mm) and make up ca. 30% by volume, while quartz (<15 vol%) occur in recrystallized aggregates. Monoclinic amphibole (tremolite or anthophyllite) occur as elongate grains (1-2 mm) in slightly radiating aggregates (30-40 vol%), and are commonly partly replaced by white mica (5-10 vol%). The presence of tremolite/anthophyllite suggest that the rock is Mg-rich. Grain 4 is ground too far down, and only the basal section of a few amphibole grains can be recognized; however, it appears to be similar to Fragment 3.

Comments:
Fragment 1 is rich in hydrous layer silicates and fine grained quartz and Fragment 2 is a quartzite. Fragments 3 and 4 contain less than 15 vol% quartz, and are probably chemically stable, although the bladed and acicular nature of some of the constituent minerals (micas, amphiboles) may give the fragments poor to fair physical stability. Unless components represented by fragments 3 and 4 dominate, an aggregete composed of fragments represented in this sample will be unsuitable for concrete.

Sample no.: **86-6090-C**
Location: **GANDER**

Rocktype: Sedimentary (mica-schist)

Description:
Quartz is the dominant mineral (ca. 75 vol%). Most grains are recrystallized, and very few strained grains occur. Plagioclase (ca. 5-10 vol%) occur as strained grains with a preferred shape orientation parallel to the mica-dominated foliation. Green biotite (ca. 5 vol%) defines the fabric, and is locally partly replaced by green chlorite. Accessory components: epidote.

Comments:
The high proportion of quartz in this sample mmay possibly render an aggregate rich in this component unsuitable for concrete.

Sample no.: **86-6090-F**
Location: **GANDER**

FRAGMENTS 1 AND 2

Rocktype: Mica-schist

Description:
This rock is a quartz-rich mica-schist with a foliation defined by biotite laths. Quartz occurs in finegrained recrystallized aggregates, and tourmaline is the only accessory phase. Rusty staining is evident, and appears to develop from the edge towards the center of the specimen, often following planar discontinuities.

FRAGMENT 3

Rocktype: Mica-schist/gneiss

Description:
This specimen is similar to grains 1 and 2, but contains a higher proportion of gray-brown biotite (10-20 vol% as opposed to <5 vol%). A few sericitized feldspar grains occur. The rock is generally recrystallized, and there is no evidence of a planar fabric.

FRAGMENT 4

Rocktype: Granitoid

Description:
This rock is a medium grained (0.5-1.0 mm) granitoid composed of quartz and plagioclase in the ratio 1:2. Quartz is clear and rarely strained, whereas most feldspar grains are heavily sericitized. Biotite, muscovite and chlorite are accessory phases.

FRAGMENT 5

Rocktype: Mica-schist

Description:
This sample contains a well developed foliation defined by biotite, which locally is partly replaced by chlorite. Quartz (ca. 30 vol%) occurs in recrystallized aggregates, and plagioclase (ca. 30 vol%) is generally sericitized. Accessory opaques occur as well.

Comments:
Each fragment contains at least 25 vol% quartz, and other deleterious components include sericite in feldspars and chlorite from biotites. Fragments of mica schist generally have a well developed planar fabric which may act as fluid pathways and thus increase the rate of deleterious (hydration) reactions.

Sample no.: **86-6093-C**
Location: **GOOSE BAY**

FRAGMENTS 1 AND 2

Rocktype: Garnet mica-schist

Description:
Garnet makes up ca. 5-10 vol% and occurs as 3-4 mm round grains. Biotite laths (0.1-1.0 mm) define the planar fabric. Quartz (ca. 50 vol%) grains are variably recrystallized; some grains still preserve evidence of earlier strain. Feldspars (ca. 50 vol%) are only slightly sericitized.

FRAGMENT 3

Rocktype: Amphibolite/dioritic gneiss

Description:
Plagioclase (grain size 0.5 to 2.0 mm) is the dominant mineral (ca. 75 vol%), and grains are variably sericitized; some grains are totally replaced by white mica. Hornblende makes up ca. 20 vol%, and biotite (locally partly replaced by chlorite) and epidote are accessory phases.

Comments:
High proportions of (strained) quartz in the mica schists, and the high degree of hydration (sericitization) of feldspars possibly renders these fragments unsuitable in concrete aggregates.

APPENDIX C2

THIN SECTION ANALYSIS

SECTION II

LOCATION	SAMPLE NO.
Swift Current	85-3006
Swift Current	85-3017
Swift Current	85-3047
Swift Current	85-3050
Pipers Hole	85-3065
Black River Pt.	85-3161
Holyrood	86-6001
Port aux Basques	86-6002
Stephenville	86-6005
Gallants	86-6006A, 6006B
Lewisporte	86-6089
Eastport	86-6091
Goose Bay	86-6093
Marystown	86-6094
Seal Cove	88-GA01A, GA01B

A.J. Cole - April 1988

Sample no.: **85-3006**
Location: **Swift Current**

Rocktype: Altered felsic volcanic

Description:
Quartz and feldspar comprise approx. 70% of the sample. Feldspar is generally highly sericitized. Epidote (ca. 20%) and chlorite (ca. 10%) are minor alteration constituents. Almost all quartz grains are strained.

Sample no.: **85-3017**
Location: **Swift Current**

Rocktype: Altered mafic volcanic/ diabase

Description:
Comprised entirely of sericitized plagioclase and chlorite. Minor epidote. No visable quartz.

Sample no.: **85-3047**
Location: **Swift Current**

Rocktype: Altered basic volcanic

Description:
Sericitized plagioclase (ca. 40%) with pyroxene and chlorite (ca. 25%) are the major constituents. Epidote (ca. 20%) is a secondary mineral. Minor (ca. <15%) opaques. No visable quartz.

Sample no.: **85-3050**
Location: **Swift Current**

Rocktype: Felsic tuff / Volcaniclastic

Description:
Section contains approx. 80% weakly sericitized plagioclase. Minor (ca. 20%) chlorite and amphibole. Minor opaques. No visable quartz.

Sample no.: **85-3065**
Location: **Pipers Hole**

Rocktype: Felsic tuff/ volcaniclastic

Description:
Very fine grained. Approx. 60% plagioclase, quartz and sericite. Approx. 40% aphanitic matrix.

Sample no.: **85-3161**
Location: **Black River Point**

Rocktype: Granitoid

Description:
Section contains approximately 40% weakly sericitized plagioclase, and 30% potassium feldspar. The approx. 25% quartz is almost entirely unstrained. Trace amounts (<5%) of mafic minerals.

Sample no.: **86-6001**
Location: **Holyrood**

Rocktype: Granitoid

Description:
Contains approximately 50% combined plagioclase and potassium feldspar. Quartz is generally unstrained, although weak undulatory extinction is apparent in some grains. Quartz is partially recrystallized along grain boundaries.

Sample no.: **86-6002**
Location: **Port aux Basques**

Rocktype: Granitoid

Description:
Contains approximately 70% highly sericitized feldspar. The quartz (ca. 15%) is both strained and recrystallized. Approx. 70% of the quartz shows undulatory extinction.

Sample no.: **86-6005**
Location: **Stephenville**

Rocktype: Altered basalt

Description:
Plagioclase (ca. 40%) occurs as phenocrysts and laths. Amphibole occurs as a major (ca. 60%) secondary constituent. Minor pyroxene. No visable quartz.

Sample no.: **86-6006a**
Location: **Gallants**

Rocktype: Diorite

Description:
Section composed almost entirely of plagioclase (ca. 50%) and amphibole (ca. 40%). Minor chlorite and trace quartz and muscovite.

Sample no.: **86-6006b**
Location: **Gallants**

Rocktype: Altered felsic volcanic/ volcaniclastic

Description:
Section is composed primarily (ca. 50%) of sericitized plagioclase. Quartz is generally unstrained and comprises approximately 20% of the section. Chlorite (ca. 15%) and opaques (ca. 15%).

Sample no.: **86-6089**
Location: **Lewisporte**

Rocktype: Diorite

Description:
Amphibole and epidote combine to comprise 45-50% of this section. Plagioclase forms approximately 40% and is weakly sericitized. Quartz comprises approximately 10 - 15% and is generally unstrained.

Sample no.: **86-6091**
Location: **Eastport**

Rocktype: Granitoid

Description:
Plagioclase and potassium feldspar comprise approximately 70% of the section. The feldspar grains are generally unaltered. Quartz occurs in variable grain size and is generally unstrained.

Sample no.: **86-6093**
Location: **Goose Bay**

Rocktype: Granite

Description:
This section contains approximately 75% combined plagioclase and potassium feldspar. The feldspar is generally highly sericitized. The majority of the quartz is unstrained. Approximately 20% shows weak undulatory extinction.

Sample no.: **86-6094**
Location: **Marystown**

Rocktype: Rhyolite

Description:
Section contains approximately 65% microcrystalline quartz, of which approximately 85% occurs as groundmass. Plagioclase comprises the remaining 35% and is generally weakly sericitized.

Sample no.: **88-GA01a**
Location: **Seal Cove**

Rocktype: Granite

Description:
Contains approximately 55% feldspar, 35% quartz and 10% chlorite. All quartz is strained to some degree. Microbrecciated zones contain recrystallized quartz.

Sample no.: **88-GA01b**
Location: **Seal Cove**

Rocktype: Granite

Description:
Section contains approximately 55% feldspar, 40% quartz and 5% chlorite and pyroxene. The quartz is generally unstrained.

APPENDIX D

EXPANSION TEST DATA

D - 1	Spread Sheets
D - 2	Expansion Graphs

STUDY OF THE ALKALI REACTIVITY OF POTENTIAL CONCRETE AGGREGATE OF NEWFOUNDLAND

TABLE D1

MORTAR BAR/CONCRETE PRISM INDEX

Sample No.	Mortar Bar	Concrete Prism
85 3006	X	
85 3008	X	
85 3017	X	
85 3032	X	
85 3047	X	X
85 3050	X	
85 3058	X	
85 3065	X	
85 3066	X	
85 3161	X	
85 6200	X	
85 6213/6214	X	
85 6214	X	
85 6215/6216	X	
86 6001	X	X
86 6002	X	X
86 6003	X	X
86 6004	X	X
86 6005	X	

TABLE D1 (cont'd)

Sample No.	Mortar Bar	Concrete Prism
86 6006	X	
86 6007	X	
86 6008	X	
86 6089	X	
86 6090	X	X
86 6091	X	
86 6093	X	
86 6094	X	X
86 6095	X	X
86 6096	X	X
88 GA01	X	X
88 GA02	X	X
88 GA03	X	X
88 GA04	X	
88 GA05	X	
CONTROL SAMPLES		
Inert Sand #1	X	
Inert Sand #2	X	
Pittsburg		X
Sudbury		X
Spratt	X	X

861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3006 LOCATION: SWIFT CURRENT, NFLD. DATE CAST: APRIL 6, 1988

MIX PROPORTIONS

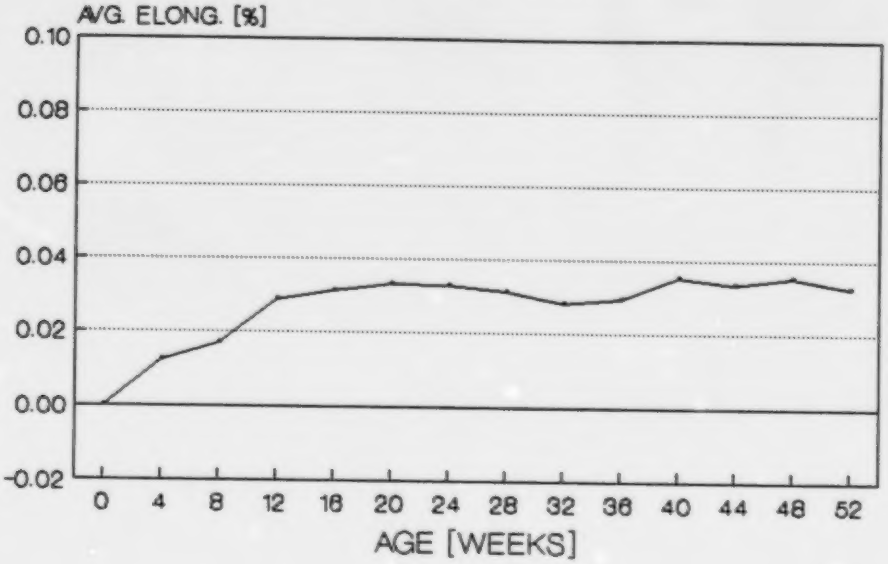
CEMENT 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 113.4mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1731	0.1722	0.1699	0.1717	0.000	0.000	0.000	0.000	0.000
APR 21/88	2	0.1741	0.1728	0.1706	0.1723	0.010	0.006	0.007	0.006	0.008
MAY 05/88	4	0.1746	0.1740	0.1711	0.1720	0.016	0.019	0.012	0.003	0.012
JUN 02/88	8	0.1751	0.1744	0.1715	0.1725	0.021	0.023	0.017	0.008	0.017
JUN 30/88	12	0.1763	0.1754	0.1725	0.1738	0.033	0.033	0.027	0.022	0.029
JUL 28/88	16	0.1766	0.1756	0.1729	0.1739	0.036	0.035	0.031	0.023	0.031
AUG 25/88	20	0.1768	0.1759	0.1730	0.1740	0.038	0.038	0.032	0.024	0.033
SEP 22/88	24	0.1767	0.1759	0.1730	0.1740	0.037	0.038	0.032	0.024	0.033
OCT 20/88	28	0.1764	0.1759	0.1728	0.1739	0.034	0.038	0.030	0.023	0.031
NOV 17/88	32	0.1764	0.1754	0.1725	0.1735	0.034	0.033	0.027	0.019	0.028
DEC 15/88	36	0.1765	0.1756	0.1726	0.1736	0.035	0.035	0.028	0.020	0.030
JAN 12/89	40	0.1770	0.1761	0.1731	0.1743	0.041	0.041	0.033	0.027	0.035
FEB 09/89	44	0.1771	0.1757	0.1729	0.1741	0.042	0.036	0.031	0.025	0.034
MAR 09/89	48	0.1771	0.1762	0.1731	0.1742	0.042	0.042	0.033	0.026	0.036
APR 06/89	52	0.1768	0.1758	0.1729	0.1740	0.038	0.037	0.031	0.024	0.033

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3006



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3008   LOCATION: SWIFT CURRENT, NFLD.   DATE CAST: APRIL 11,1988

MIX PROPORTIONS

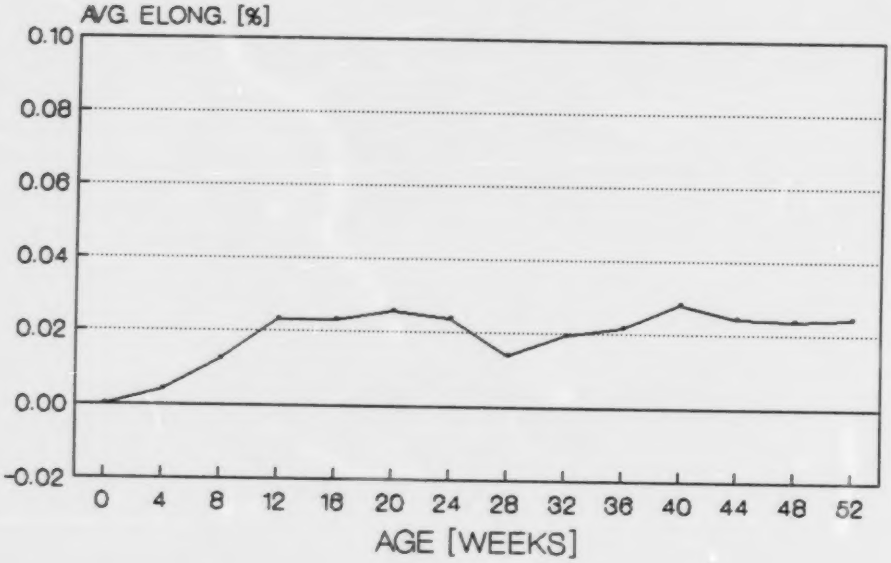
CEMENT: 300g   WATER: 110g   FINE AGGREGATE: 675g   FLOW: 106mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1740	0.1698	0.1714	0.1754	0.000	0.000	0.000	0.000	0.000
APR 26/88	2	0.1742	0.1697	0.1712	0.1755	0.002	-0.001	-0.002	0.001	0.000
MAY 10/88	4	0.1743	0.1701	0.1717	0.1760	0.003	0.003	0.003	0.006	0.004
JUN 07/88	8	0.1751	0.1710	0.1726	0.1767	0.011	0.012	0.012	0.014	0.012
JUL 05/88	12	0.1761	0.1720	0.1737	0.1778	0.022	0.023	0.024	0.025	0.023
AUG 02/88	16	0.1761	0.1720	0.1737	0.1778	0.022	0.023	0.024	0.025	0.023
AUG 30/88	20	0.1764	0.1722	0.1739	0.1780	0.025	0.025	0.026	0.027	0.026
SEP 27/88	24	0.1763	0.1722	0.1737	0.1776	0.024	0.025	0.024	0.023	0.024
OCT 25/88	28	0.1750	0.1712	0.1732	0.1765	0.010	0.015	0.019	0.011	0.014
NOV 22/88	32	0.1757	0.1717	0.1734	0.1773	0.018	0.020	0.021	0.020	0.019
DEC 20/88	36	0.1761	0.1718	0.1736	0.1774	0.022	0.021	0.023	0.021	0.022
JAN 17/89	40	0.1765	0.1726	0.1743	0.1781	0.026	0.029	0.030	0.028	0.028
FEB 14/89	44	0.1764	0.1723	0.1737	0.1777	0.025	0.026	0.024	0.024	0.025
MAR 14/89	48	0.1762	0.1723	0.1737	0.1776	0.023	0.026	0.024	0.023	0.024
APR 11/89	52	0.1763	0.1722	0.1738	0.1778	0.024	0.025	0.025	0.025	0.025

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3008



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3017 LOCATION: SWIFT CURRENT, NFLD. DATE CAST: APRIL 8,1988

MIX PROPORTIONS

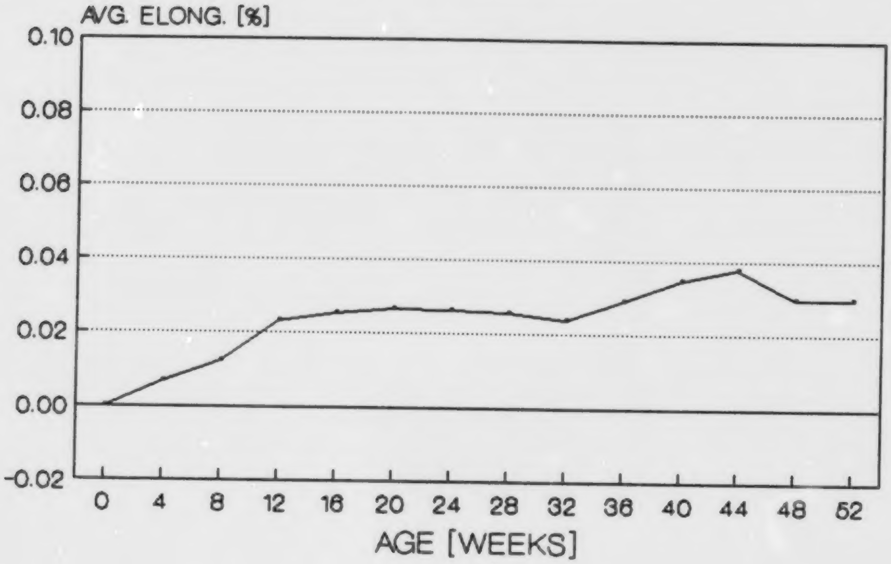
CEMENT: 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 110mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1735	0.1782	0.1742	0.1795	0.000	0.000	0.000	0.000	0.000
APR 23/88	2	0.1738	0.1787	0.1740	0.1789	0.003	0.005	-0.002	-0.006	-0.000
MAY 07/88	4	0.1744	0.1793	0.1746	0.1797	0.009	0.011	0.004	0.002	0.007
JUN 04/88	8	0.1749	0.1798	0.1752	0.1803	0.015	0.017	0.010	0.008	0.012
JUL 02/88	12	0.1760	0.1808	0.1762	0.1813	0.026	0.027	0.021	0.019	0.023
JUL 30/88	16	0.1763	0.1811	0.1763	0.1815	0.029	0.030	0.022	0.021	0.025
AUG 27/88	20	0.1764	0.1812	0.1764	0.1817	0.030	0.031	0.023	0.023	0.027
SEP 24/88	24	0.1763	0.1812	0.1762	0.1819	0.029	0.031	0.021	0.025	0.027
OCT 22/88	28	0.1764	0.1812	0.1761	0.1816	0.030	0.031	0.020	0.022	0.026
NOV 19/88	32	0.1760	0.1811	0.1760	0.1815	0.026	0.030	0.019	0.021	0.024
DEC 17/88	36	0.1766	0.1816	0.1765	0.1820	0.032	0.035	0.024	0.026	0.029
JAN 14/89	40	0.1775	0.1825	0.1765	0.1823	0.042	0.045	0.024	0.029	0.035
FEB 11/89	44	0.1775	0.1823	0.1774	0.1828	0.042	0.043	0.033	0.034	0.038
MAR 11/89	48	0.1766	0.1818	0.1765	0.1820	0.032	0.037	0.024	0.026	0.030
APR 08/89	52	0.1766	0.1816	0.1765	0.1822	0.032	0.035	0.024	0.028	0.030

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3017



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3032 LOCATION: SWIFT CURRENT, NFLD. DATE CAST: APRIL 4, 1988

MIX PROPORTIONS

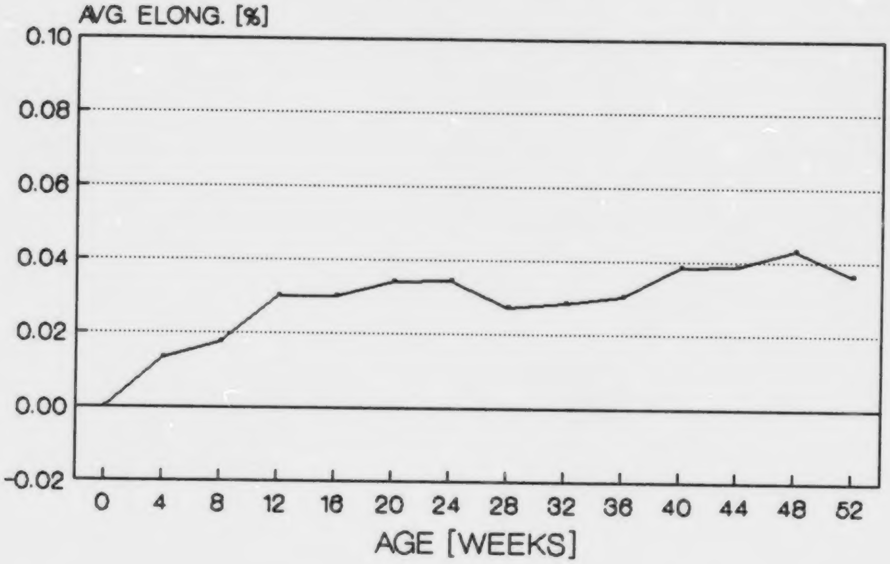
CEMENT: 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 109.7mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1745	0.1770	0.1675	0.1684	0.000	0.000	0.000	0.000	0.000
APR 19/88	2	0.1747	0.1767	0.1673	0.1688	0.002	-0.003	-0.002	0.004	0.000
MAY 03/88	4	0.1760	0.1780	0.1685	0.1700	0.016	0.010	0.010	0.017	0.013
MAY 31/88	8	0.1765	0.1784	0.1690	0.1703	0.021	0.015	0.016	0.020	0.018
JUN 28/88	12	0.1777	0.1796	0.1701	0.1716	0.033	0.027	0.027	0.033	0.030
JUL 26/88	16	0.1777	0.1796	0.1701	0.1716	0.033	0.027	0.027	0.033	0.030
AUG 23/88	20	0.1782	0.1800	0.1704	0.1720	0.038	0.031	0.030	0.037	0.034
SEP 20/88	24	0.1782	0.1799	0.1705	0.1721	0.038	0.030	0.031	0.038	0.035
OCT 18/88	28	0.1775	0.1791	0.1698	0.1715	0.031	0.022	0.024	0.032	0.027
NOV 15/88	32	0.1778	0.1796	0.1696	0.1714	0.034	0.027	0.022	0.031	0.029
DEC 13/88	36	0.1779	0.1797	0.1700	0.1715	0.035	0.028	0.026	0.032	0.030
JAN 10/89	40	0.1789	0.1804	0.1705	0.1725	0.046	0.035	0.031	0.043	0.039
FEB 07/89	44	0.1789	0.1801	0.1708	0.1726	0.046	0.032	0.034	0.044	0.039
MAR 07/89	48	0.1792	0.1808	0.1712	0.1728	0.049	0.039	0.038	0.046	0.043
APR 04/89	52	0.1785	0.1802	0.1706	0.1721	0.042	0.033	0.032	0.038	0.036

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3032



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3047 LOCATION: SWIFT CURRENT, NFLD. DATE CAST: APRIL 11,1988

MIX PROPORTIONS

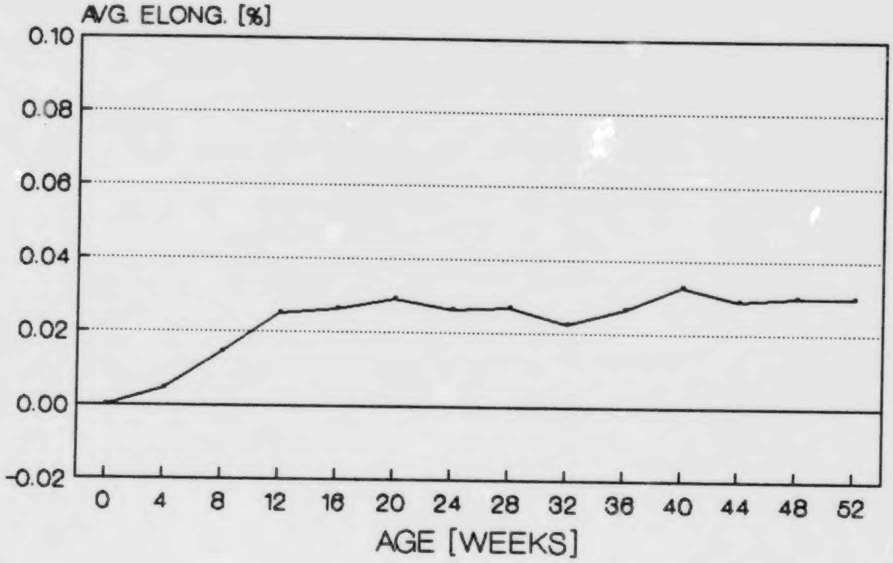
CEMENT: 310g WATER: 110g FINE AGGREGATE: 697.5g FLOW: 114.7mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1759	0.1761	0.1740	0.1780	0.000	0.000	0.000	0.000	0.000
APR 26/88	2	0.1759	0.1759	0.1744	0.1777	0.000	-0.002	0.004	-0.003	-0.000
MAY 10/88	4	0.1763	0.1763	0.1749	0.1782	0.004	0.002	0.009	0.002	0.004
JUN 07/88	8	0.1773	0.1773	0.1758	0.1792	0.015	0.012	0.019	0.012	0.015
JUL 05/88	12	0.1784	0.1783	0.1769	0.1801	0.026	0.023	0.030	0.022	0.025
AUG 02/88	16	0.1784	0.1785	0.1770	0.1803	0.026	0.025	0.031	0.024	0.026
AUG 30/88	20	0.1787	0.1788	0.1772	0.1806	0.029	0.028	0.033	0.027	0.029
SEP 27/88	24	0.1784	0.1785	0.1768	0.1805	0.026	0.025	0.029	0.026	0.026
OCT 25/88	28	0.1782	0.1789	0.1771	0.1802	0.024	0.029	0.032	0.023	0.027
NOV 22/88	32	0.1779	0.1783	0.1767	0.1798	0.021	0.023	0.028	0.019	0.023
DEC 20/88	36	0.1785	0.1786	0.1768	0.1804	0.027	0.026	0.029	0.025	0.027
JAN 17/89	40	0.1791	0.1791	0.1773	0.1812	0.033	0.031	0.034	0.033	0.033
FEB 14/89	44	0.1787	0.1790	0.1771	0.1805	0.029	0.030	0.032	0.026	0.029
MAR 14/89	48	0.1785	0.1791	0.1773	0.1807	0.027	0.031	0.034	0.028	0.030
APR 11/89	52	0.1786	0.1791	0.1772	0.1807	0.028	0.031	0.033	0.028	0.030

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3047



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE.PRISMS

SAMPLE NO: 85-3047   LOCATION: SWIFT CURRENT, NFLD.   DATE CAST: MAY 9,1988

MIX PROPORTIONS

CEMENT: 2170g   WATER: 930g   SLUMP: 90mm

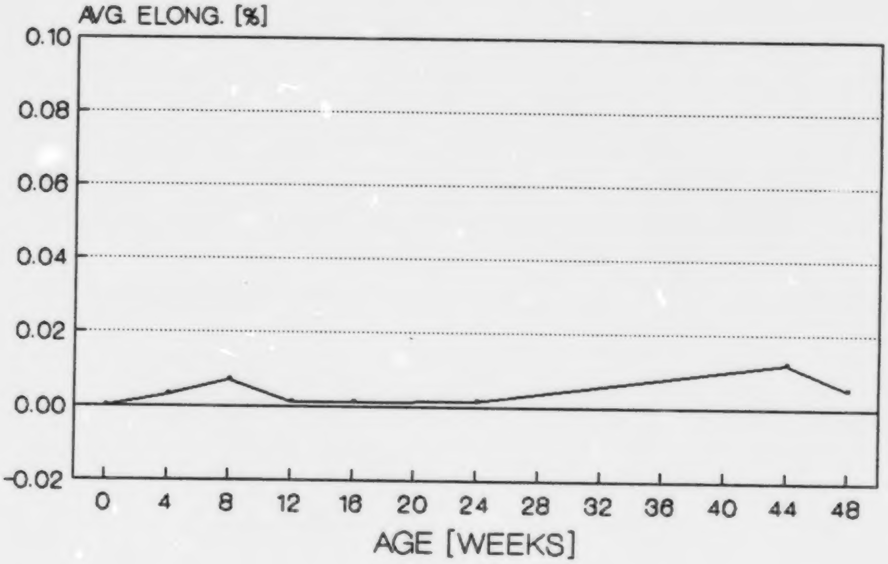
COARSE AGGREGATE: 7180g   FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6735	0.6891	0.7210	0.000	0.000	0.000	0.000
MAY 17/88	1	0.6735	0.6893	0.7209	0.000	0.002	-0.001	0.000
MAY 24/88	2	0.6739	0.6895	0.7211	0.004	0.004	0.001	0.003
JUN 07/88	4	0.6739	0.6895	0.7212	0.004	0.004	0.002	0.003
JUL 05/88	8	0.6743	0.6899	0.7218	0.007	0.007	0.007	0.007
AUG 02/88	12	0.6737	0.6894	0.7209	0.002	0.003	-0.001	0.001
AUG 30/88	16	0.6734	0.6891	0.7215	-0.001	0.000	0.004	0.001
OCT 25/88	24	0.6738	0.6892	0.7211	0.003	0.001	0.001	0.001
MAR 14/89	44	0.6752	0.6906	0.7219	0.015	0.013	0.008	0.012
APR 11/89	48	0.6743	0.6895	0.7216	0.007	0.004	0.005	0.005

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 85-3047



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3050 LOCATION: SWIFT CURRENT, NFLD. DATE CAST: APRIL 9,1988

MIX PROPORTIONS

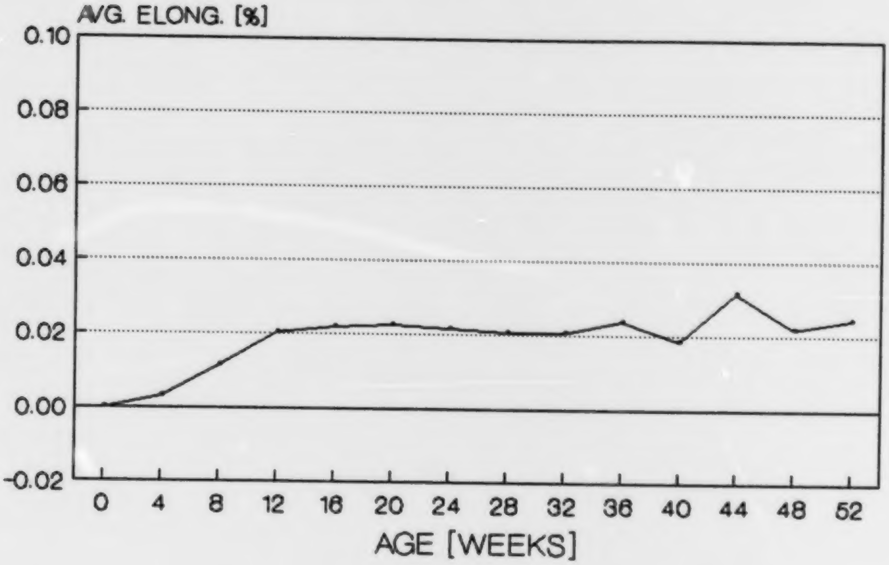
CEMENT: 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 113.6mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1720	0.1768	0.1709	0.1718	0.000	0.000	0.000	0.000	0.000
APR 24/88	2	0.1718	0.1765	0.1711	0.1716	-0.002	-0.003	0.002	-0.002	-0.001
MAY 08/88	4	0.1722	0.1769	0.1715	0.1721	0.002	0.001	0.006	0.003	0.003
JUN 05/88	8	0.1730	0.1777	0.1723	0.1729	0.010	0.009	0.015	0.011	0.011
JUL 03/88	12	0.1738	0.1786	0.1732	0.1738	0.019	0.019	0.024	0.021	0.021
JUL 31/88	16	0.1740	0.1788	0.1733	0.1739	0.021	0.021	0.025	0.022	0.022
AUG 28/98	20	0.1740	0.1788	0.1734	0.1740	0.021	0.021	0.026	0.023	0.023
SEP 25/88	24	0.1739	0.1787	0.1733	0.1740	0.020	0.020	0.025	0.023	0.022
OCT 23/88	28	0.1740	0.1787	0.1731	0.1737	0.021	0.020	0.023	0.020	0.021
NOV 20/88	32	0.1740	0.1787	0.1731	0.1737	0.021	0.020	0.023	0.020	0.021
DEC 18/88	36	0.1742	0.1790	0.1734	0.1741	0.023	0.023	0.026	0.024	0.024
JAN 15/89	40	0.1737	0.1784	0.1730	0.1735	0.018	0.017	0.022	0.018	0.018
FEB 12/89	44	0.1749	0.1799	0.1741	0.1748	0.030	0.032	0.033	0.031	0.032
MAR 12/89	48	0.1739	0.1788	0.1734	0.1739	0.020	0.021	0.026	0.022	0.022
APR 09/89	52	0.1743	0.1790	0.1735	0.1741	0.024	0.023	0.027	0.024	0.024

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3050



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3058   LOCATION: SWIFT CURRENT, NFLD.   DATE CAST: APRIL 8,1988

MIX PROPORTIONS

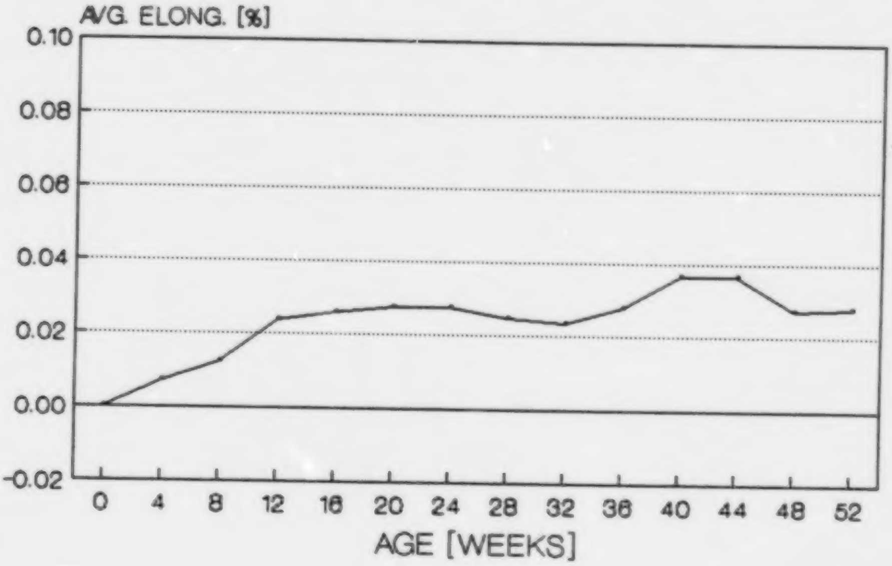
CEMENT: 300g   WATER: 110g   FINE AGGREGATE: 675g   FLOW: 111.8mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1745	0.1765	0.1746	0.1766	0.000	0.000	0.000	0.000	0.000
APR 23/88	2	0.1746	0.1769	0.1740	0.1768	0.001	0.004	-0.006	0.002	0.000
MAY 07/88	4	0.1752	0.1775	0.1747	0.1775	0.007	0.010	0.001	0.009	0.007
JUN 04/88	8	0.1757	0.1781	0.1752	0.1780	0.012	0.017	0.006	0.015	0.012
JUL 02/88	12	0.1768	0.1792	0.1763	0.1791	0.024	0.028	0.018	0.026	0.024
JUL 30/88	16	0.1770	0.1794	0.1764	0.1794	0.026	0.030	0.019	0.029	0.026
AUG 27/88	20	0.1770	0.1797	0.1766	0.1795	0.026	0.033	0.021	0.030	0.028
SEP 24/88	24	0.1772	0.1796	0.1766	0.1794	0.028	0.032	0.021	0.029	0.028
OCT 22/88	28	0.1769	0.1791	0.1766	0.1792	0.025	0.027	0.021	0.027	0.025
NOV 19/88	32	0.1765	0.1793	0.1763	0.1792	0.021	0.029	0.018	0.027	0.024
DEC 17/88	36	0.1771	0.1798	0.1766	0.1795	0.027	0.034	0.021	0.030	0.028
JAN 14/89	40	0.1778	0.1807	0.1774	0.1804	0.034	0.044	0.029	0.039	0.037
FEB 11/89	44	0.1778	0.1805	0.1775	0.1805	0.034	0.042	0.030	0.041	0.037
MAR 11/89	48	0.1767	0.1800	0.1766	0.1794	0.023	0.036	0.021	0.029	0.027
APR 08/89	52	0.1770	0.1797	0.1765	0.1797	0.026	0.033	0.020	0.032	0.028

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3058



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3065 LOCATION: PIPER'S HOLE, NFLD. DATE CAST: APRIL 19, 1988

MIX PROPORTIONS

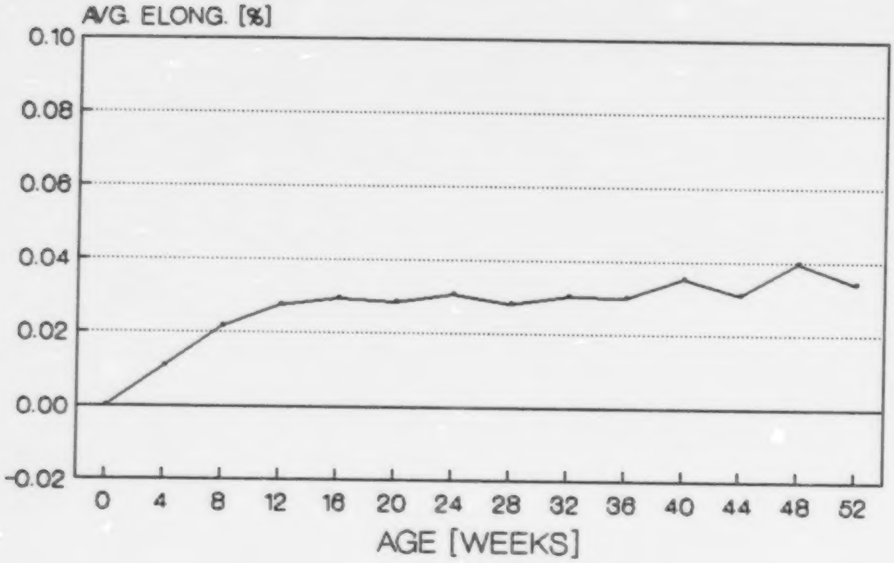
CEMENT: 300g WATER: 115g FINE AGGREGATE: 675g FLOW: 109.5mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1952	0.2065	0.1780	0.1735	0.000	0.000	0.000	0.000	0.000
MAY 04/88	2	0.1950	0.2067	0.1777	0.1739	-0.002	0.002	-0.003	0.004	0.000
MAY 18/88	4	0.1960	0.2076	0.1789	0.1748	0.008	0.011	0.009	0.014	0.011
JUN 15/88	8	0.1969	0.2087	0.1799	0.1760	0.018	0.023	0.020	0.026	0.022
JUL 13/88	12	0.1975	0.2092	0.1804	0.1767	0.024	0.028	0.025	0.033	0.028
AUG 10/88	16	0.1975	0.2095	0.1806	0.1769	0.024	0.031	0.027	0.035	0.029
SEP 07/88	20	0.1975	0.2093	0.1806	0.1768	0.024	0.029	0.027	0.034	0.029
OCT 05/88	24	0.1976	0.2098	0.1807	0.1769	0.025	0.034	0.028	0.035	0.031
NOV 02/88	28	0.1972	0.2098	0.1805	0.1766	0.021	0.034	0.026	0.032	0.028
NOV 30/88	32	0.1975	0.2099	0.1807	0.1768	0.024	0.035	0.028	0.034	0.030
DEC 28/88	36	0.1975	0.2097	0.1809	0.1767	0.024	0.033	0.030	0.033	0.030
JAN 25/89	40	0.1982	0.2102	0.1815	0.1769	0.031	0.039	0.036	0.035	0.035
FEB 22/89	44	0.1976	0.2096	0.1808	0.1771	0.025	0.032	0.029	0.037	0.031
MAR 22/89	48	0.1984	0.2105	0.1817	0.1779	0.033	0.042	0.038	0.046	0.040
APR 19/89	52	0.1979	0.2100	0.1811	0.1774	0.028	0.036	0.032	0.041	0.034

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3065



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3066 LOCATION: PIPER'S HOLE, NFLD. DATE CAST: APRIL 5,1988

MIX PROPORTIONS

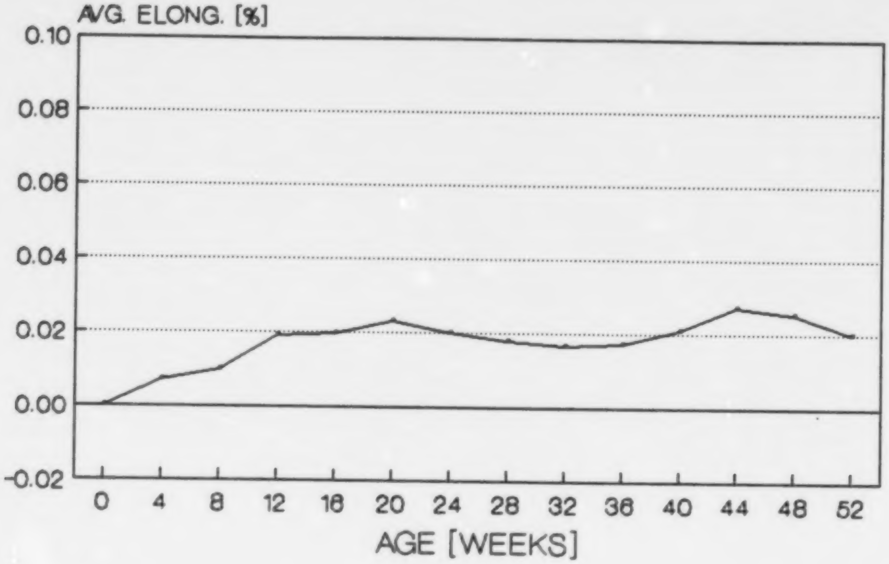
CEMENT: 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 118.8mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1730	0.1785	0.1745	0.1754	0.000	0.000	0.000	0.000	0.000
APR 20/88	2	0.1736	0.1785	0.1749	0.1751	0.006	0.000	0.004	-0.003	0.002
MAY 04/88	4	0.1742	0.1788	0.1755	0.1756	0.012	0.003	0.010	0.002	0.007
JUN 01/88	8	0.1745	0.1791	0.1757	0.1759	0.016	0.006	0.012	0.005	0.010
JUN 29/88	12	0.1754	0.1799	0.1767	0.1768	0.025	0.015	0.023	0.015	0.019
JUL 27/88	16	0.1755	0.1800	0.1767	0.1768	0.026	0.016	0.023	0.015	0.020
AUG 24/88	20	0.1758	0.1804	0.1770	0.1772	0.029	0.020	0.026	0.019	0.023
SEP 21/88	24	0.1755	0.1801	0.1767	0.1769	0.026	0.017	0.023	0.016	0.020
OCT 19/88	28	0.1752	0.1799	0.1765	0.1767	0.023	0.015	0.021	0.014	0.018
NOV 16/88	32	0.1752	0.1798	0.1764	0.1764	0.023	0.014	0.020	0.010	0.017
DEC 14/88	36	0.1750	0.1802	0.1761	0.1768	0.021	0.018	0.017	0.015	0.017
JAN 11/89	40	0.1755	0.1803	0.1768	0.1769	0.026	0.019	0.024	0.016	0.021
FEB 08/89	44	0.1762	0.1808	0.1773	0.1776	0.033	0.024	0.029	0.023	0.027
MAR 08/89	48	0.1761	0.1807	0.1772	0.1772	0.032	0.023	0.028	0.019	0.025
APR 05/89	52	0.1755	0.1802	0.1766	0.1768	0.026	0.018	0.022	0.015	0.020

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3066



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-3161 LOCATION: BLACK RIVER POINT, NFLD. DATE CAST: APRIL 4,1988

MIX PROPORTIONS

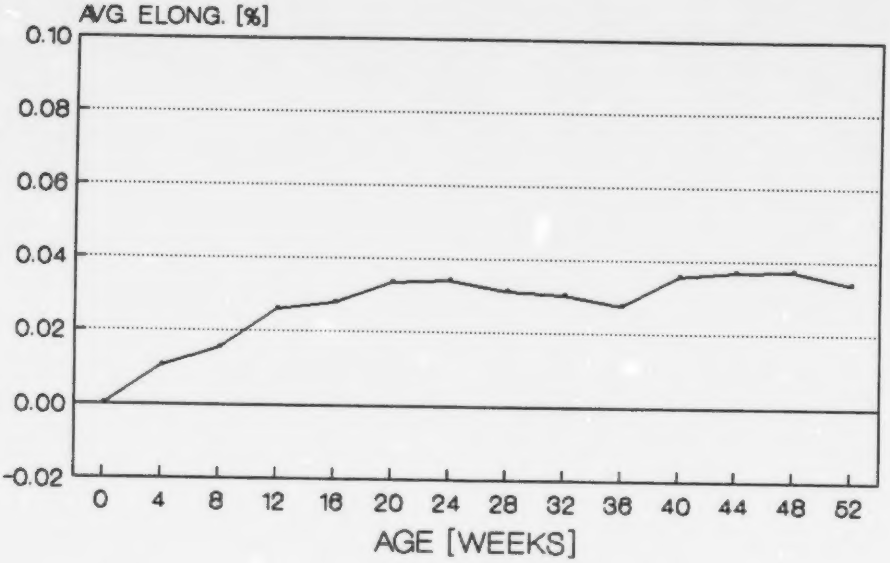
CEMENT: 300g WATER: 115g FINE AGGREGATE: 675g FLOW: 111.4mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1686	0.1642	0.1755	0.1750	0.000	0.000	0.000	0.000	0.000
APR 19/88	2	0.1684	0.1640	0.1755	0.1751	-0.002	-0.002	0.000	0.001	-0.001
MAY 03/88	4	0.1695	0.1651	0.1766	0.1761	0.009	0.009	0.011	0.011	0.010
MAY 31/88	8	0.1699	0.1656	0.1773	0.1765	0.013	0.015	0.019	0.016	0.016
JUN 28/88	12	0.1710	0.1667	0.1785	0.1772	0.025	0.026	0.031	0.023	0.026
JUL 26/88	16	0.1711	0.1668	0.1785	0.1777	0.026	0.027	0.031	0.028	0.028
AUG 23/88	20	0.1717	0.1674	0.1790	0.1781	0.032	0.033	0.036	0.032	0.033
SEP 20/88	24	0.1718	0.1675	0.1789	0.1783	0.033	0.034	0.035	0.034	0.034
OCT 18/88	28	0.1716	0.1672	0.1786	0.1780	0.031	0.031	0.032	0.031	0.031
NOV 15/88	32	0.1715	0.1672	0.1784	0.1779	0.030	0.031	0.030	0.030	0.030
DEC 13/88	36	0.1712	0.1669	0.1783	0.1776	0.027	0.028	0.029	0.027	0.028
JAN 10/89	40	0.1721	0.1674	0.1793	0.1783	0.036	0.033	0.039	0.034	0.036
FEB 07/89	44	0.1721	0.1675	0.1794	0.1786	0.036	0.034	0.041	0.037	0.037
MAR 07/89	48	0.1724	0.1677	0.1794	0.1782	0.039	0.036	0.041	0.033	0.037
APR 04/89	52	0.1718	0.1674	0.1790	0.1782	0.033	0.033	0.036	0.033	0.034

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-3161



361.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-6200   LOCATION: ADAM'S HEAD, NFLD   DATE CAST: APRIL 13,1988

MIX PROPORTIONS

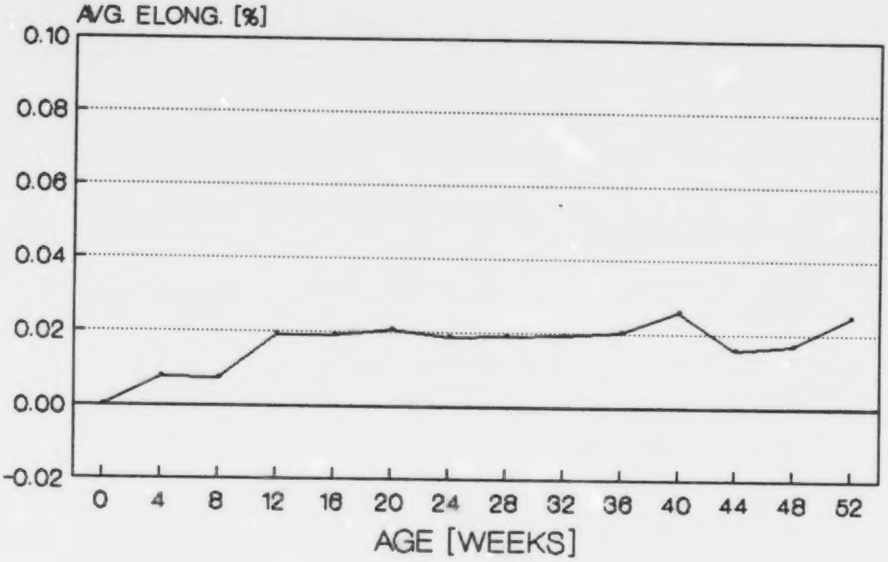
CEMENT: 300g   WATER: 115g   FINE AGGREGATE: 675g   FLOW: 105.1g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1772	0.1826	0.1766	0.1806	0.000	0.000	0.000	0.000	0.000
APR 28/88	2	0.1776	0.1823	0.1762	0.1803	0.004	-0.003	-0.004	-0.003	-0.002
MAY 12/88	4	0.1782	0.1828	0.1768	0.1821	0.010	0.002	0.002	0.016	0.008
JUN 09/88	8	0.1784	0.1831	0.1771	0.1812	0.012	0.005	0.005	0.006	0.007
JUL 07/88	12	0.1797	0.1842	0.1782	0.1823	0.026	0.017	0.017	0.018	0.019
AUG 04/88	16	0.1797	0.1842	0.1782	0.1823	0.026	0.017	0.017	0.018	0.019
SEP 01/88	20	0.1798	0.1843	0.1784	0.1825	0.027	0.018	0.019	0.020	0.021
SEP 29/88	24	0.1794	0.1842	0.1783	0.1824	0.023	0.017	0.018	0.019	0.019
OCT 27/88	28	0.1795	0.1840	0.1784	0.1825	0.024	0.015	0.019	0.020	0.019
NOV 24/88	32	0.1796	0.1843	0.1783	0.1823	0.025	0.018	0.018	0.018	0.019
DEC 22/88	36	0.1797	0.1843	0.1784	0.1825	0.026	0.018	0.019	0.020	0.021
JAN 19/89	40	0.1803	0.1851	0.1787	0.1829	0.032	0.026	0.022	0.024	0.026
FEB 16/89	44	0.1793	0.1837	0.1780	0.1821	0.022	0.011	0.015	0.016	0.016
MAR 16/89	48	0.1791	0.1843	0.1780	0.1822	0.020	0.018	0.015	0.017	0.017
APR 13/89	52	0.1800	0.1851	0.1787	0.1827	0.029	0.026	0.022	0.022	0.025

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-6200



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 85-6214 LOCATION: ADAM'S HEAD, NFLD. DATE CAST: APRIL 20,1988

MIX PROPORTIONS

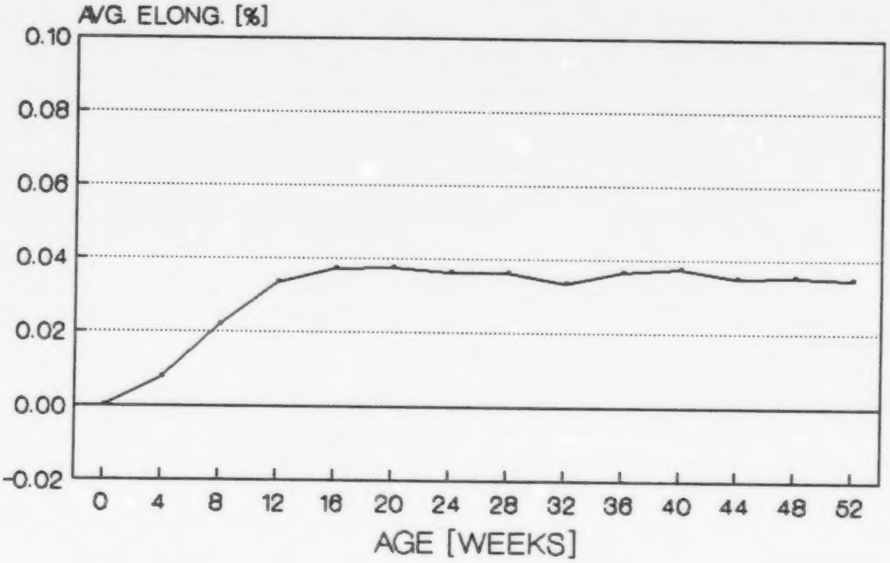
CEMENT: 300g WATER: 125g FINE AGGREGATE: 675g FLOW: 109mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1696	0.1730	0.1689	0.1675	0.000	0.000	0.000	0.000	0.000
MAY 05/88	2	0.1697	0.1729	0.1690	0.1682	0.001	-0.001	0.001	0.007	0.002
MAY 19/88	4	0.1702	0.1736	0.1693	0.1689	0.006	0.006	0.004	0.015	0.008
JUN 16/88	8	0.1716	0.1750	0.1706	0.1703	0.021	0.021	0.018	0.029	0.022
JUL 14/88	12	0.1727	0.1759	0.1717	0.1716	0.032	0.030	0.029	0.043	0.033
AUG 11/88	16	0.1731	0.1763	0.1721	0.1719	0.036	0.034	0.033	0.046	0.037
SEP 08/88	20	0.1731	0.1763	0.1721	0.1720	0.036	0.034	0.033	0.047	0.038
OCT 06/88	24	0.1730	0.1763	0.1718	0.1719	0.035	0.034	0.030	0.046	0.036
NOV 03/88	28	0.1730	0.1762	0.1719	0.1719	0.035	0.033	0.031	0.046	0.036
DEC 01/88	32	0.1727	0.1760	0.1716	0.1716	0.032	0.031	0.028	0.043	0.033
DEC 29/88	36	0.1734	0.1763	0.1717	0.1717	0.039	0.034	0.029	0.044	0.037
JAN 26/89	40	0.1736	0.1765	0.1717	0.1717	0.042	0.036	0.029	0.044	0.038
FEB 23/89	44	0.1730	0.1760	0.1719	0.1716	0.035	0.031	0.031	0.043	0.035
MAR 23/89	48	0.1730	0.1762	0.1717	0.1717	0.035	0.033	0.029	0.044	0.035
APR 20/89	52	0.1728	0.1762	0.1717	0.1717	0.033	0.033	0.029	0.044	0.035

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 85-6214



361.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 85-6213/6214 LOCATION: ADAM'S HEAD, NFLD. DATE CAST: MAY 13, 1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 970g SLUMP: 70mm

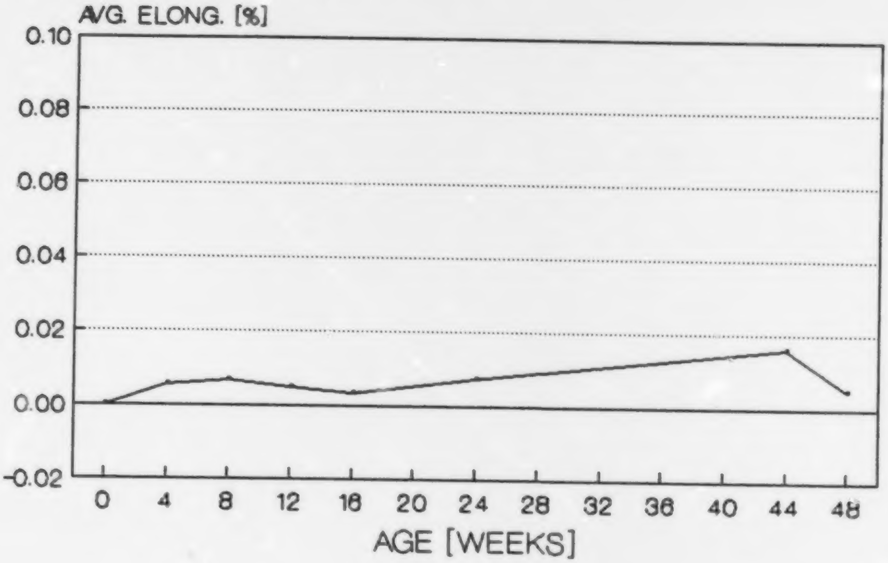
COARSE AGGREGATE: 7180g FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE (WEEKS)	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.7667	0.7191	0.7978	0.000	0.000	0.000	0.000
MAY 21/88	1	0.7666	0.7189	0.7981	-0.001	-0.002	0.003	-0.000
MAY 28/88	2	0.7667	0.7182	0.7992	0.000	-0.009	0.004	-0.002
JUN 11/88	4	0.7675	0.7197	0.7982	0.007	0.006	0.004	0.006
JUL 09/88	8	0.7678	0.7193	0.7988	0.010	0.002	0.009	0.007
AUG 06/88	12	0.7672	0.7195	0.7985	0.004	0.004	0.006	0.005
SEP 03/88	16	0.7672	0.7193	0.7982	0.004	0.002	0.004	0.003
OCT 29/88	24	0.7671	0.7200	0.7989	0.004	0.009	0.010	0.007
MAR 18/89	44	0.7680	0.7209	0.7999	0.011	0.018	0.018	0.016
APR 15/89	48	0.7672	0.7196	0.7984	0.004	0.005	0.005	0.005

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 85-6213/6214



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 85-6215/6216 LOCATION: ADAM'S HEAD, NFLD. DATE CAST: MAY 17,1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 830g SLUMP: 70mm

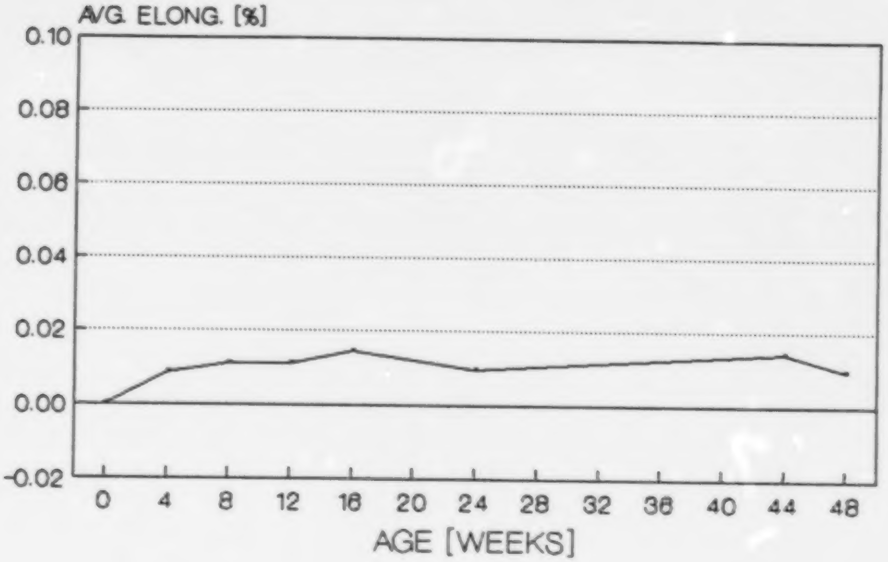
COARSE AGGREGATE: 7180g FINE AGGREGATE: 6730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.7741	0.6436	0.7863	0.000	0.000	0.000	0.000
MAY 25/88	1	0.7749	0.6446	0.7870	0.007	0.009	0.006	0.007
JUN 01/88	2	0.7747	0.6450	0.7871	0.005	0.012	0.007	0.008
JUN 15/88	4	0.7749	0.6446	0.7874	0.007	0.009	0.010	0.009
JUL 13/88	8	0.7747	0.6453	0.7878	0.005	0.015	0.013	0.011
AUG 10/88	12	0.7748	0.6451	0.7879	0.006	0.013	0.014	0.011
SEP 07/88	16	0.7749	0.6455	0.7885	0.007	0.017	0.019	0.014
NOV 02/88	24	0.7746	0.6448	0.7878	0.004	0.011	0.013	0.009
MAR 22/89	44	0.7750	0.6460	0.7878	0.008	0.021	0.013	0.014
APR 19/89	48	0.7749	0.6443	0.7880	0.007	0.006	0.015	0.009

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 85-6215/6216



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 86-6001 LOCATION: HOLYROOD, NFLD. DATE CAST: APRIL 12,1988

MIX PROPORTIONS

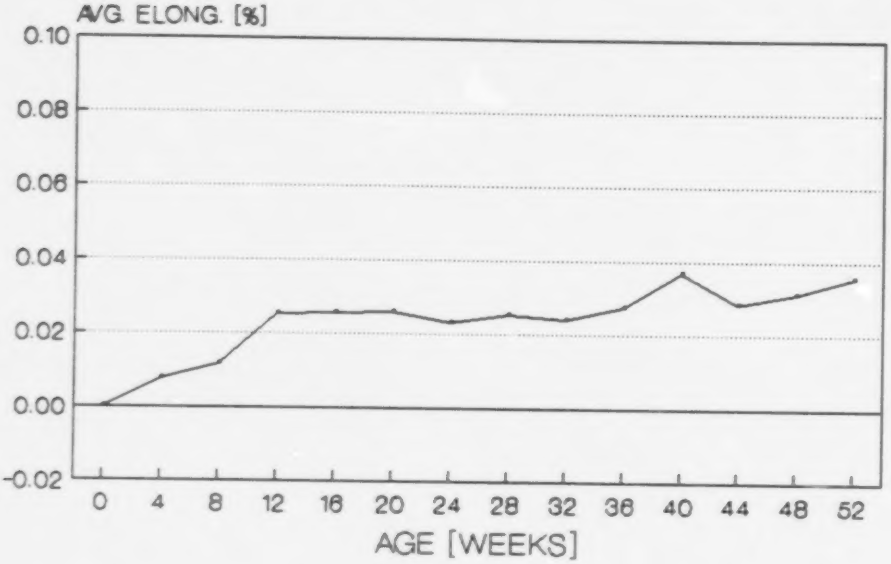
CEMENT: 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 107mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1764	0.1766	0.1682	0.1688	0.000	0.000	0.000	0.000	0.000
APR 27/88	2	0.1767	0.1770	0.1685	0.1685	0.003	0.004	0.003	-0.003	0.002
MAY 11/88	4	0.1772	0.1775	0.1691	0.1691	0.008	0.009	0.009	0.003	0.008
JUN 08/88	8	0.1775	0.1780	0.1695	0.1695	0.011	0.015	0.013	0.007	0.012
JUL 06/88	12	0.1789	0.1792	0.1708	0.1709	0.026	0.027	0.027	0.022	0.025
AUG 03/88	16	0.1789	0.1793	0.1708	0.1709	0.026	0.028	0.027	0.022	0.026
AUG 31/88	20	0.1789	0.1793	0.1709	0.1710	0.026	0.028	0.028	0.023	0.026
SEP 28/88	24	0.1786	0.1791	0.1706	0.1707	0.023	0.026	0.025	0.020	0.023
OCT 26/88	28	0.1788	0.1792	0.1709	0.1709	0.025	0.027	0.028	0.022	0.025
NOV 23/88	32	0.1788	0.1791	0.1707	0.1707	0.025	0.026	0.026	0.020	0.024
DEC 21/88	36	0.1790	0.1795	0.1710	0.1711	0.027	0.030	0.029	0.024	0.028
JAN 18/89	40	0.1800	0.1804	0.1718	0.1721	0.037	0.039	0.037	0.034	0.037
FEB 15/89	44	0.1791	0.1796	0.1712	0.1711	0.028	0.031	0.031	0.024	0.029
MAR 15/89	48	0.1794	0.1800	0.1713	0.1714	0.031	0.035	0.032	0.027	0.031
APR 12/89	52	0.1800	0.1805	0.1717	0.1716	0.037	0.041	0.036	0.029	0.036

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 86-6001



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6001   LOCATION: HOLYROOD, NFLD.   DATE CAST: MAY 12,1988

MIX PROPORTIONS

CEMENT: 6200g   WATER: 3120g   FLOW: 80mm

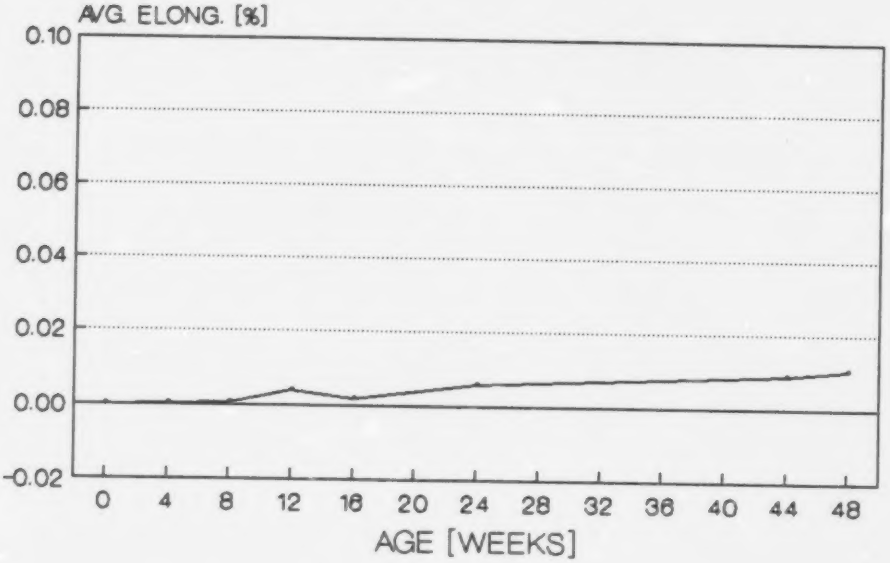
COARSE AGGREGATE: 20 520g   FINE AGGREGATE: 16 380g

LENGTH MEASUREMENTS

	AGE (WEEKS)	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.7290	0.7342	0.6925	0.000	0.000	0.000	0.000
MAY 20/88	1	0.7289	0.7341	0.6925	-0.001	-0.001	0.000	-0.001
MAY 27/88	2	0.7296	0.7340	0.6928	0.005	-0.002	0.003	0.002
JUN 10/88	4	0.7293	0.7344	0.6921	0.003	0.002	-0.004	0.000
JUL 08/88	8	0.7286	0.7354	0.6919	-0.004	0.011	-0.005	0.001
AUG 05/88	12	0.7288	0.7356	0.6926	-0.002	0.012	0.001	0.004
SEP 02/88	16	0.7292	0.7351	0.6920	0.002	0.008	-0.004	0.002
OCT 28/88	24	0.7294	0.7359	0.6924	0.004	0.015	-0.001	0.006
MAR 17/89	44	0.7298	0.7353	0.6936	0.007	0.010	0.010	0.009
APR 14/89	48	0.7294	0.7359	0.6939	0.004	0.015	0.012	0.010

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6001



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 86-6002 LOCATION: PORT AUX BASQUES, NFLD. DATE CAST: APRIL 13,1988

MIX PROPORTIONS

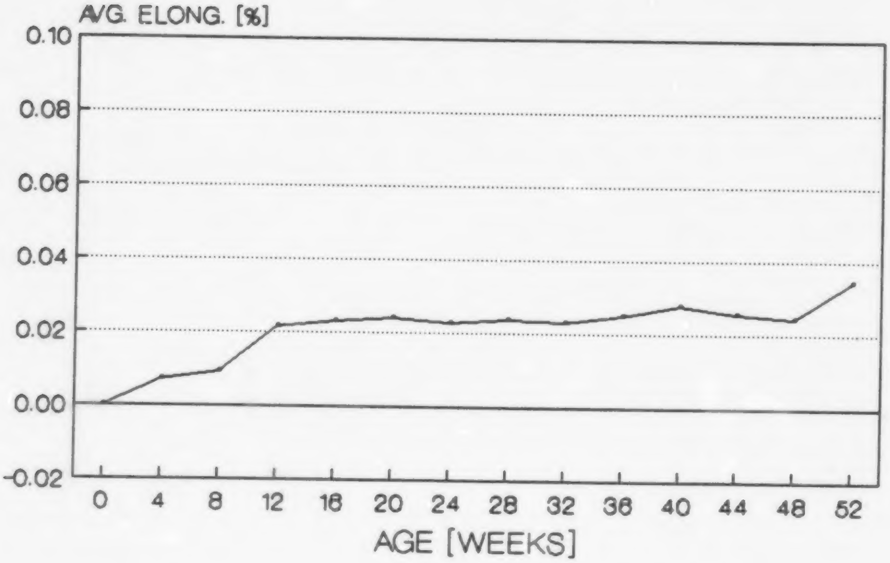
CEMENT: 300g WATER: 115g FINE AGGREGATE: 675g FLOW: 105.6mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1698	0.1716	0.1780	0.1818	0.000	0.000	0.000	0.000	0.000
APR 28/88	2	0.1699	0.1718	0.1783	0.1820	0.001	0.002	0.003	0.002	0.002
MAY 12/88	4	0.1704	0.1724	0.1787	0.1824	0.006	0.008	0.007	0.006	0.007
JUN 09/88	8	0.1705	0.1727	0.1791	0.1825	0.007	0.011	0.011	0.007	0.009
JUL 07/88	12	0.1718	0.1739	0.1801	0.1838	0.021	0.024	0.022	0.021	0.022
AUG 04/88	16	0.1719	0.1740	0.1802	0.1840	0.022	0.025	0.023	0.023	0.023
SEP 01/88	20	0.1719	0.1741	0.1804	0.1841	0.022	0.026	0.025	0.024	0.024
SEP 29/88	24	0.1718	0.1740	0.1802	0.1840	0.021	0.025	0.023	0.023	0.023
OCT 27/88	28	0.1719	0.1742	0.1803	0.1840	0.022	0.027	0.024	0.023	0.024
NOV 24/88	32	0.1718	0.1741	0.1802	0.1840	0.021	0.026	0.023	0.023	0.023
DEC 22/88	36	0.1720	0.1742	0.1805	0.1842	0.023	0.027	0.026	0.025	0.025
JAN 19/89	40	0.1723	0.1746	0.1807	0.1844	0.026	0.031	0.028	0.027	0.028
FEB 16/89	44	0.1721	0.1743	0.1805	0.1842	0.024	0.028	0.026	0.025	0.026
MAR 16/89	48	0.1717	0.1743	0.1804	0.1843	0.020	0.028	0.025	0.026	0.025
APR 13/89	52	0.1728	0.1751	0.1815	0.1851	0.031	0.036	0.036	0.034	0.035

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 86-6002



361.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6002   LOCATION: PORT AUX BASQUES, NFLD.   DATE CAST: MAY 18, 19

MIX PROPORTIONS

CEMENT: 2170g   WATER: 780g   SLUMP: 70mm

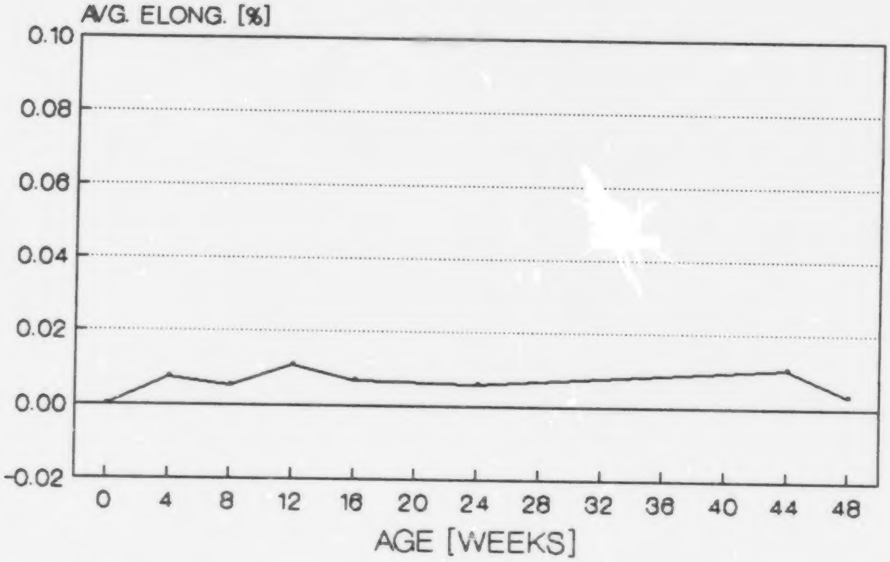
COARSE AGGREGATE: 7180g   FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6547	0.6618	0.7229	0.000	0.000	0.000	0.000
MAY 26/88	1	0.6559	0.6631	0.7238	0.011	0.012	0.008	0.010
JUN 02/88	2	0.6550	0.6632	0.7237	0.003	0.012	0.007	0.007
JUN 16/88	4	0.6550	0.6630	0.7239	0.003	0.011	0.009	0.007
JUL 14/88	8	0.6550	0.6625	0.7236	0.003	0.006	0.006	0.005
AUG 11/88	12	0.6555	0.6634	0.7241	0.007	0.014	0.011	0.011
SEP 08/88	16	0.6558	0.6625	0.7234	0.010	0.006	0.004	0.007
NOV 03/88	24	0.6555	0.6621	0.7238	0.007	0.003	0.008	0.006
MAR 23/89	44	0.6559	0.6624	0.7246	0.011	0.005	0.015	0.010
APR 20/89	48	0.6552	0.6622	0.7231	0.004	0.004	0.002	0.003

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6002



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

PROJECT NO.: 86-6003 LOCATION: STEPHENVILLE, NFLD. DATE CAST: APRIL 15,1988

MIX PROPORTIONS

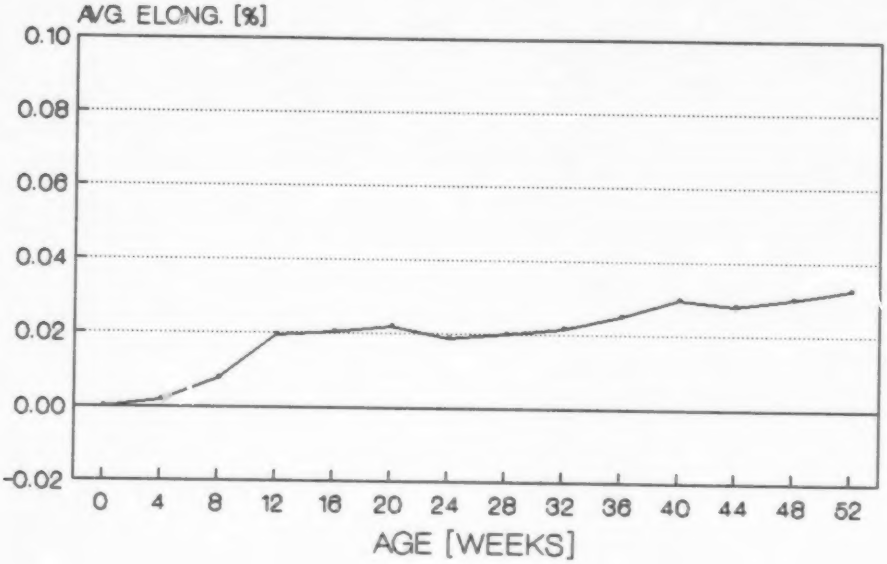
CEMENT: 300g WATER: 120g FINE AGGREGATE: 675g FLOW: 105.5mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1943	0.1918	0.2008	0.2225	0.000	0.000	0.000	0.000	0.000
APR 30/88	2	0.1938	0.1924	0.2004	0.2229	-0.005	0.006	-0.004	0.004	0.000
MAY 14/88	4	0.1939	0.1924	0.2007	0.2231	-0.004	0.006	-0.001	0.006	0.002
JUN 11/88	8	0.1944	0.1930	0.2013	0.2237	0.001	0.012	0.005	0.013	0.008
JUL 09/88	12	0.1956	0.1940	0.2024	0.2249	0.014	0.023	0.017	0.025	0.020
AUG 06/88	16	0.1957	0.1941	0.2024	0.2250	0.015	0.024	0.017	0.026	0.020
SEP 03/88	20	0.1959	0.1943	0.2025	0.2252	0.017	0.026	0.018	0.028	0.022
OCT 01/88	24	0.1957	0.1940	0.2022	0.2248	0.015	0.023	0.015	0.024	0.019
OCT 29/88	28	0.1959	0.1942	0.2022	0.2248	0.017	0.025	0.015	0.024	0.020
NOV 26/88	32	0.1960	0.1942	0.2025	0.2250	0.018	0.025	0.018	0.026	0.022
DEC 24/88	36	0.1964	0.1945	0.2028	0.2254	0.022	0.028	0.021	0.030	0.025
JAN 21/89	40	0.1965	0.1948	0.2036	0.2259	0.023	0.031	0.029	0.036	0.030
FEB 18/89	44	0.1965	0.1949	0.2032	0.2257	0.023	0.032	0.025	0.033	0.028
MAR 18/89	48	0.1965	0.1952	0.2034	0.2259	0.023	0.035	0.027	0.036	0.030
APR 15/89	52	0.1969	0.1954	0.2034	0.2262	0.027	0.037	0.027	0.039	0.033

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 86-6003



361.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6003   LOCATION: STEPHENVILLE, NFLD.   DATE CAST: MAY 26,1988

MIX PROPORTIONS

CEMENT: 2170g   WATER: 803g   SLUMP: 70mm

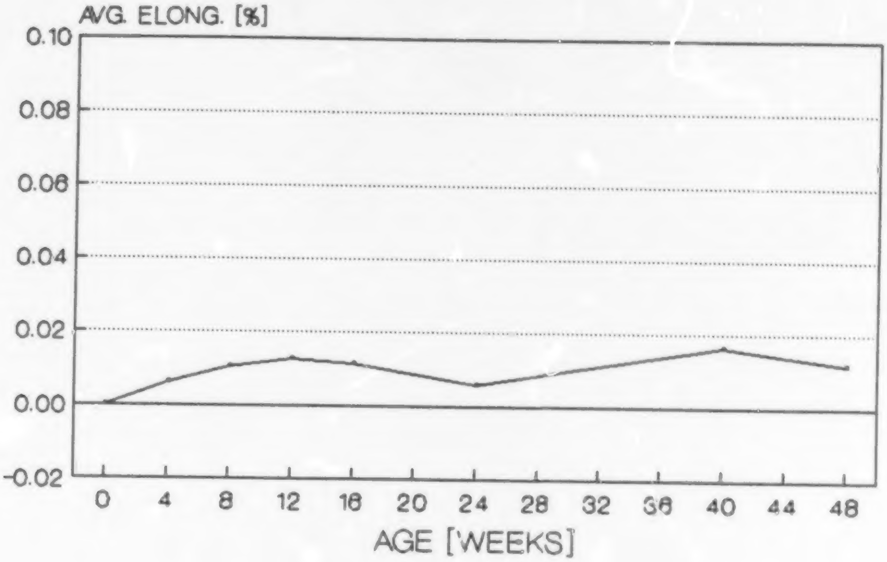
COARSE AGGREGATE: 7180g   FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE (WEEKS)	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6884	0.7588	0.6755	0.000	0.000	0.000	0.000
JUN 03/88	1	0.6886	0.7589	0.6750	0.002	0.001	-0.004	-0.001
JUN 10/88	2	0.6882	0.7592	0.6765	-0.002	0.004	0.009	0.004
JUN 24/88	4	0.6885	0.7595	0.6768	0.001	0.006	0.012	0.006
JUL 22/88	8	0.6891	0.7607	0.6765	0.006	0.017	0.009	0.011
AUG 19/88	12	0.6893	0.7611	0.6766	0.008	0.020	0.010	0.013
SEP 16/88	16	0.6890	0.7610	0.6766	0.005	0.019	0.010	0.011
NOV 11/88	24	0.6888	0.7600	0.6759	0.004	0.011	0.004	0.006
MAR 03/89	40	0.6900	0.7612	0.6771	0.014	0.021	0.014	0.017
APR 28/89	48	0.6898	0.7608	0.6761	0.012	0.018	0.005	0.012

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6003



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 86-6004 LOCATION: ST. ANTHONY, NFLD. DATE CAST: APRIL 7,1988

MIX PROPORTIONS

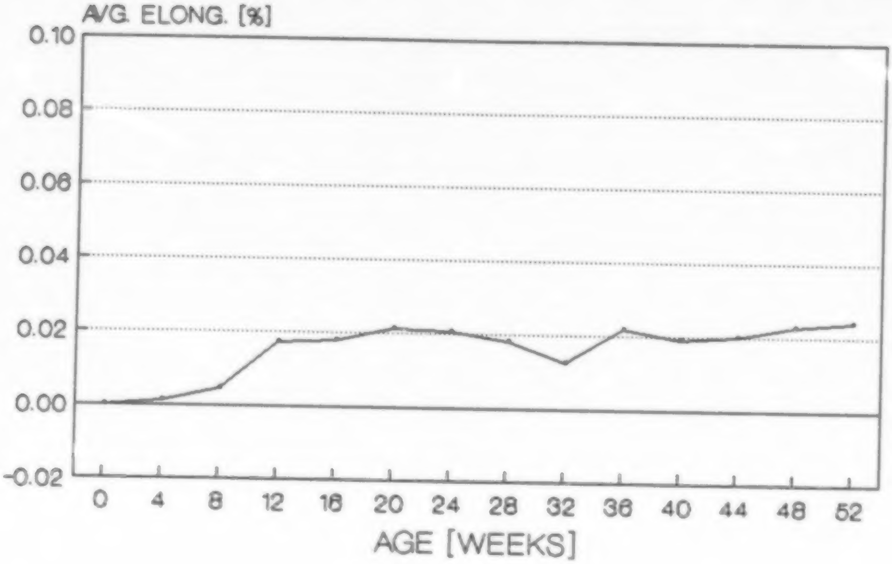
CEMENT: 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 108.2mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1650	0.1646	0.1765	0.1751	0.000	0.000	0.000	0.000	0.000
APR 22/88	2	0.1655	0.1640	0.1754	0.1745	0.005	-0.006	-0.011	-0.006	-0.005
MAY 06/88	4	0.1662	0.1647	0.1762	0.1745	0.012	0.001	-0.003	-0.006	0.001
JUN 03/88	8	0.1665	0.1651	0.1766	0.1748	0.016	0.005	0.001	-0.003	0.005
JUL 01/88	12	0.1678	0.1663	0.1778	0.1760	0.029	0.018	0.014	0.009	0.017
JUL 29/88	16	0.1679	0.1663	0.1779	0.1760	0.030	0.018	0.015	0.009	0.018
AUG 26/88	20	0.1681	0.1667	0.1782	0.1764	0.032	0.022	0.018	0.014	0.021
SEP 23/88	24	0.1681	0.1667	0.1781	0.1763	0.032	0.022	0.017	0.012	0.021
OCT 21/88	28	0.1678	0.1663	0.1780	0.1761	0.029	0.018	0.016	0.010	0.018
NOV 18/88	32	0.1673	0.1660	0.1774	0.1754	0.024	0.015	0.009	0.003	0.013
DEC 16/88	36	0.1683	0.1667	0.1783	0.1764	0.034	0.022	0.019	0.014	0.022
JAN 13/89	40	0.1678	0.1669	0.1777	0.1762	0.029	0.024	0.012	0.011	0.019
FEB 10/89	44	0.1674	0.1667	0.1782	0.1767	0.025	0.022	0.018	0.017	0.020
MAR 10/89	48	0.1682	0.1667	0.1785	0.1766	0.033	0.022	0.021	0.016	0.023
APR 07/89	52	0.1684	0.1669	0.1785	0.1767	0.035	0.024	0.021	0.017	0.024

MORTAR BAR EXPANSION GRAGH

SAMPLE NO.: 86-6004



361.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6004 LOCATION: ST. ANTHONY, NFLD. DATE CAST: MAY 19,1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 930g SLUMP: 70mm

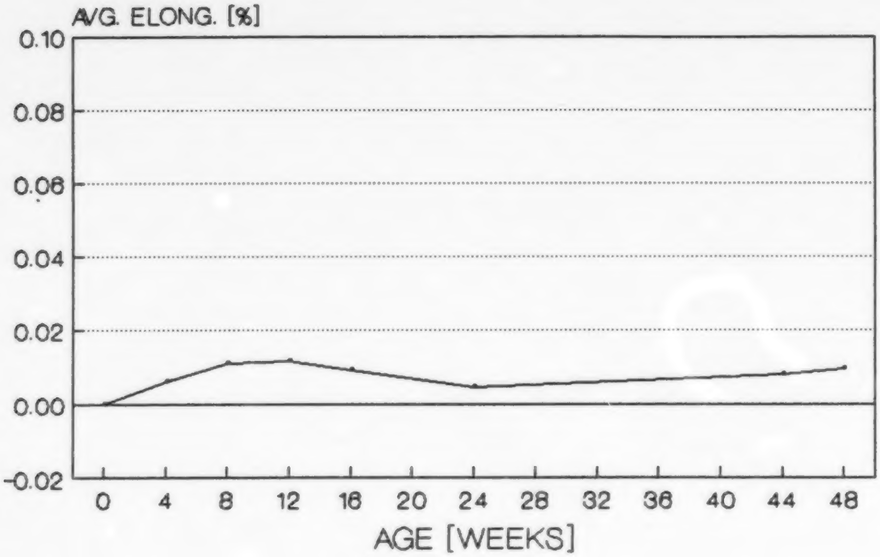
COARSE AGGREGATE: 7180g FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6372	0.7020	0.7367	0.000	0.000	0.000	0.000
MAY 27/88	1	0.6373	0.7022	0.7364	0.001	0.002	-0.003	0.000
JUN 03/88	2	0.6376	0.7018	0.7358	0.004	-0.002	-0.006	-0.002
JUN 17/88	4	0.6386	0.7022	0.7372	0.012	0.002	0.004	0.006
JUL. 15/88	8	0.6393	0.7030	0.7374	0.019	0.009	0.006	0.011
AUG 12/88	12	0.6389	0.7034	0.7376	0.015	0.012	0.008	0.012
SEP 09/86	16	0.6389	0.7027	0.7374	0.015	0.006	0.006	0.009
NOV 04/88	24	0.6385	0.7025	0.7364	0.012	0.004	-0.003	0.004
MAR 24/89	44	0.6387	0.7029	0.7370	0.013	0.008	0.003	0.008
APR 21/89	48	0.6394	0.7022	0.7375	0.020	0.002	0.007	0.009

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6004



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 86-6005 LOCATION: STEPHENVILLE, NFLD. DATE CAST: APRIL 7, 1988

MIX PROPORTIONS

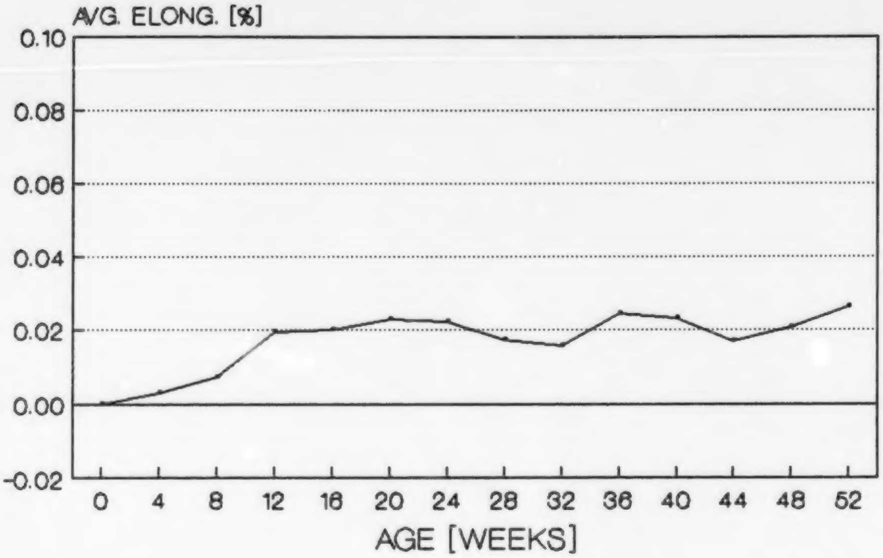
CEMENT: 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 108.4mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1712	0.1679	0.1756	0.1748	0.000	0.000	0.000	0.000	0.000
APR 22/88	2	0.1715	0.1679	0.1756	0.1737	0.003	0.000	0.000	-0.011	-0.002
MAY 06/88	4	0.1721	0.1686	0.1749	0.1751	0.009	0.007	-0.007	0.003	0.003
JUN 03/88	8	0.1725	0.1690	0.1753	0.1755	0.014	0.011	-0.003	0.007	0.007
JUL 01/88	12	0.1737	0.1701	0.1764	0.1768	0.026	0.023	0.008	0.021	0.019
JUL 29/88	16	0.1738	0.1702	0.1765	0.1768	0.027	0.024	0.009	0.021	0.020
AUG 26/88	20	0.1740	0.1705	0.1769	0.1770	0.029	0.027	0.014	0.023	0.023
SEP 23/88	24	0.1740	0.1706	0.1767	0.1768	0.029	0.028	0.011	0.021	0.022
OCT 21/88	28	0.1735	0.1702	0.1763	0.1762	0.024	0.024	0.007	0.015	0.017
NOV 18/88	32	0.1732	0.1698	0.1760	0.1766	0.021	0.020	0.004	0.019	0.016
DEC 16/88	36	0.1743	0.1708	0.1769	0.1770	0.032	0.030	0.014	0.023	0.025
JAN 13/89	40	0.1742	0.1706	0.1768	0.1769	0.031	0.028	0.012	0.022	0.023
FEB 10/89	44	0.1734	0.1699	0.1762	0.1765	0.023	0.021	0.006	0.018	0.017
MAR 10/89	48	0.1742	0.1701	0.1767	0.1765	0.031	0.023	0.011	0.018	0.021
APR 07/89	52	0.1745	0.1711	0.1770	0.1771	0.034	0.033	0.015	0.024	0.026

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 86-6005



361.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6006 LOCATION: GALLANTS, NFLD. DATE CAST: MAY 18,1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 980g SLUMP: 70mm

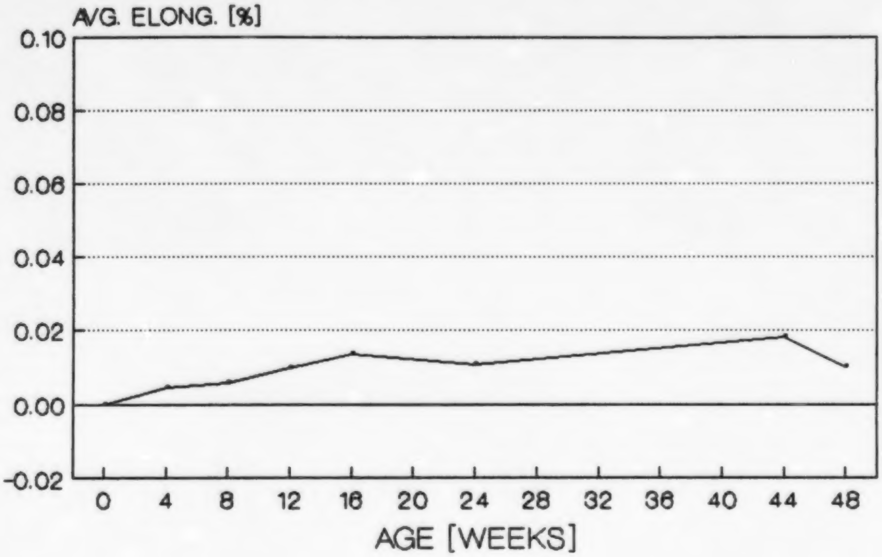
COARSE AGGREGATE: 7180g FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6679	0.6697	0.7618	0.000	0.000	0.000	0.000
MAY 26/88	1	0.6686	0.6710	0.7623	0.006	0.012	0.004	0.007
JUN 02/88	2	0.6691	0.6706	0.7626	0.011	0.008	0.007	0.009
JUN 16/88	4	0.6683	0.6705	0.7621	0.004	0.007	0.003	0.004
JUL 14/88	8	0.6692	0.6707	0.7614	0.012	0.009	-0.009	0.006
AUG 11/88	12	0.6692	0.6710	0.7625	0.012	0.012	0.006	0.010
SEP 08/88	16	0.6694	0.6720	0.7626	0.013	0.020	0.007	0.014
NOV 03/88	24	0.6688	0.6720	0.7623	0.008	0.020	0.004	0.011
MAR 23/89	44	0.6695	0.6729	0.7632	0.014	0.028	0.012	0.018
APR 20/89	48	0.6690	0.6713	0.7625	0.010	0.014	0.006	0.010

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6006



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6007 LOCATION: SPRINGDALE, NFLD. DATE CAST: MAY 14, 1988

MIX PROPORTIONS

CEMENT: 6200g WATER: 2600g SLUMP: 90mm

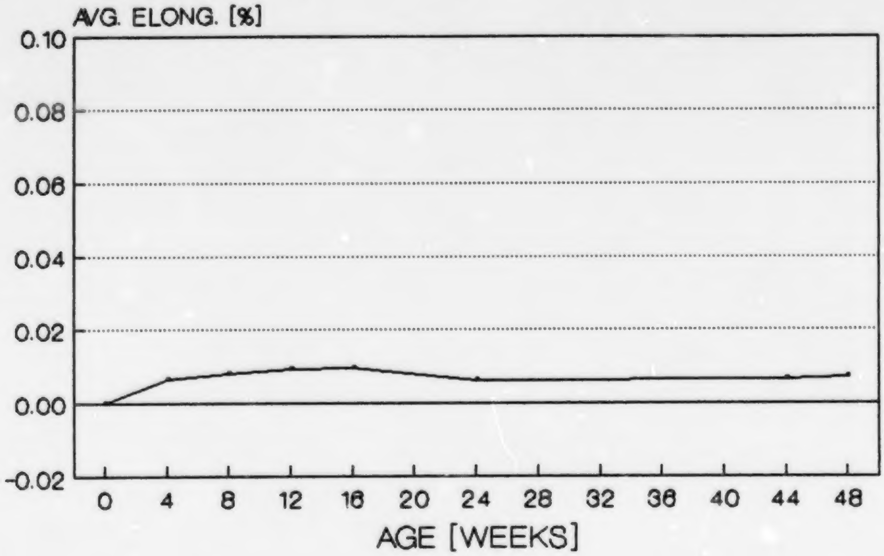
COARSE AGGREGATE: 20 520g FINE AGGREGATE: 16 380g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6974	0.6792	0.6642	0.000	0.000	0.000	0.000
MAY 22/88	1	0.6974	0.6785	0.6651	0.000	-0.006	0.008	0.001
MAY 29/88	2	0.6985	0.6780	0.6641	0.010	-0.011	-0.001	-0.001
JUN 12/88	4	0.6985	0.6793	0.6652	0.010	0.001	0.009	0.007
JUL 10/88	8	0.6989	0.6794	0.6652	0.013	0.002	0.009	0.008
AUG 07/88	12	0.6988	0.6798	0.6653	0.012	0.005	0.010	0.009
SEP 04/88	16	0.6991	0.6797	0.6652	0.015	0.004	0.009	0.009
OCT 30/88	24	0.6986	0.6790	0.6653	0.011	-0.002	0.010	0.006
MAR 19/89	44	0.6978	0.6795	0.6657	0.004	0.003	0.013	0.007
APR 16/89	48	0.6982	0.6795	0.6655	0.007	0.003	0.012	0.007

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6007



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6008   LOCATION: GRAND FALLS, NFLD.   DATE CAST: MAY 3,1988

MIX PROPORTIONS

CEMENT: 6300g   WATER: 3100g   SLUMP: 75mm

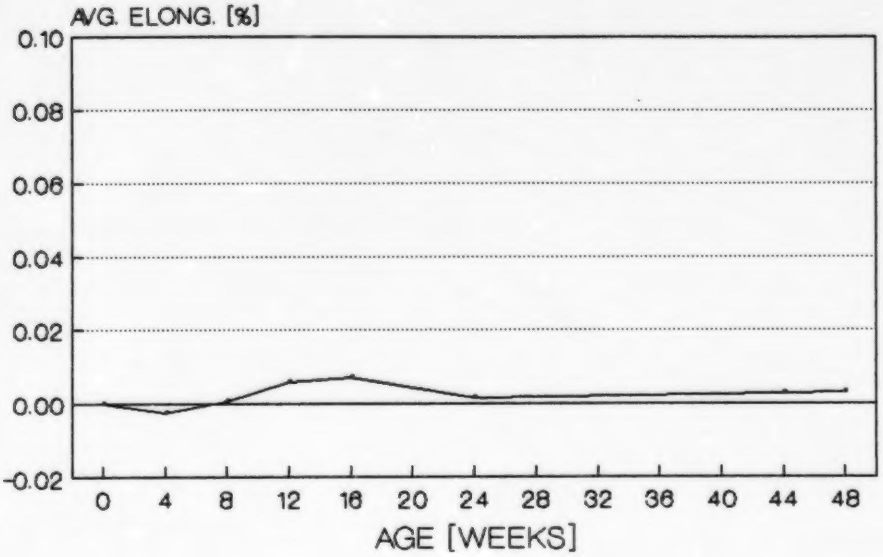
COARSE AGGREGATE: 20 520g   FINE AGGREGATE: 17 380g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6900	0.6539	0.6192	0.000	0.000	0.000	0.000
MAY 11/88	1	0.6902	0.6532	0.6193	0.002	-0.006	0.001	-0.001
MAY 18/88	2	0.6905	0.6526	0.6191	0.004	-0.012	-0.001	-0.003
JUN 01/88	4	0.6903	0.6528	0.6191	0.003	-0.010	-0.001	-0.003
JUN 29/88	8	0.6909	0.6531	0.6193	0.008	-0.007	0.001	0.001
JUL 27/88	12	0.6911	0.6537	0.6203	0.010	-0.002	0.010	0.006
AUG 24/88	16	0.6911	0.6540	0.6204	0.010	0.001	0.011	0.007
OCT 19/88	24	0.6908	0.6530	0.6198	0.007	-0.008	0.005	0.001
MAR 08/89	44	0.6915	0.6536	0.6189	0.013	-0.003	-0.003	0.003
APR 05/89	48	0.6910	0.6540	0.6191	0.009	0.001	-0.001	0.003

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6008



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6089 LOCATION: LEWISPORTE, NFLD. DATE CAST: MAY 6,1988

MIX PROPORTIONS

CEMENT: 6200g WATER: 1870g SLUMP: 75mm

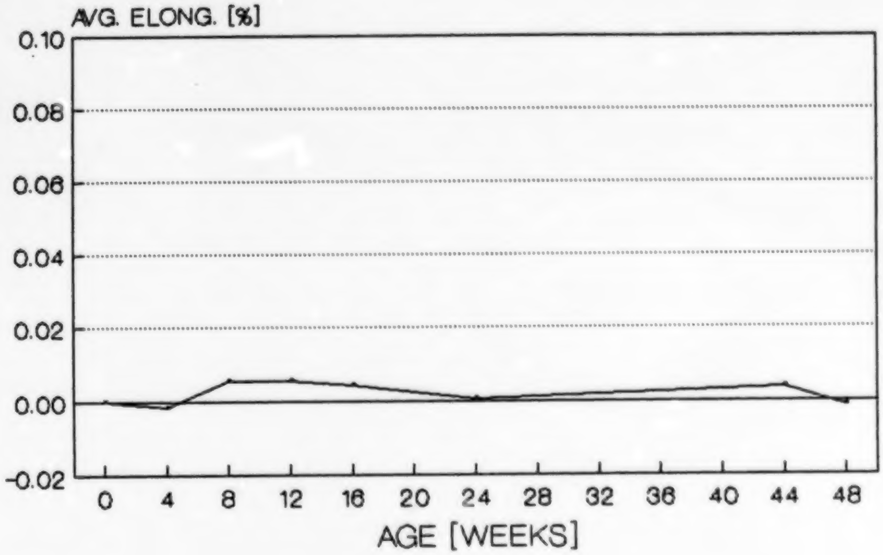
COARSE AGGREGATE: 20 520g FINE AGGREGATE: 16 380g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6412	0.6211	0.6394	0.000	0.000	0.000	0.000
MAY 14/88	1	0.6407	0.6211	0.6394	-0.004	0.000	0.000	-0.001
MAY 21/88	2	0.6397	0.6190	0.6392	-0.013	-0.019	-0.002	-0.011
JUN 04/88	4	0.6408	0.6208	0.6395	-0.004	-0.003	0.001	-0.002
JUL 02/88	8	0.6420	0.6214	0.6401	0.007	0.003	0.006	0.005
JUL 30/88	12	0.6416	0.6219	0.6400	0.004	0.007	0.005	0.005
AUG 27/88	16	0.6416	0.6219	0.6396	0.004	0.007	0.002	0.004
OCT 22/88	24	0.6406	0.6207	0.6406	-0.005	-0.004	0.011	0.001
MAR 11/89	44	0.6414	0.6212	0.6403	0.002	0.001	0.008	0.004
APR 08/89	48	0.6407	0.6215	0.6390	-0.004	0.004	-0.004	-0.001

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6089



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 86-6090   LOCATION: BUTTS POND, NFLD.   DATE CAST: APRIL 12,1988

MIX PROPORTIONS

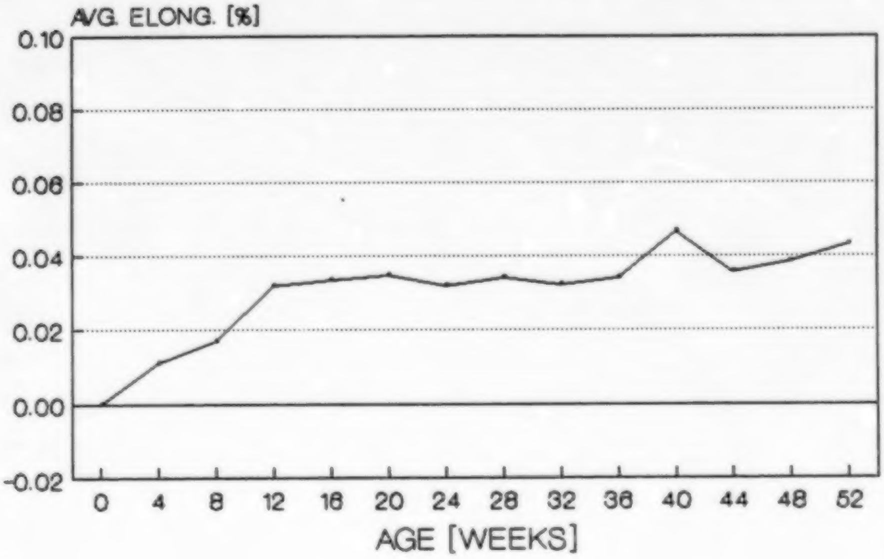
CEMENT: 300g   WATER: 110g   FINE AGGREGATE: 675g   FLOW: 108mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1742	0.1785	0.1725	0.1760	0.000	0.000	0.000	0.000	0.000
APR 27/88	2	0.1747	0.1787	0.1723	0.1767	0.005	0.002	-0.002	0.007	0.003
MAY 11/88	4	0.1755	0.1795	0.1730	0.1775	0.014	0.010	0.005	0.016	0.011
JUN 08/88	8	0.1760	0.1801	0.1735	0.1782	0.019	0.017	0.010	0.023	0.017
JUL 06/88	12	0.1774	0.1815	0.1750	0.1796	0.033	0.031	0.026	0.037	0.032
AUG 03/88	16	0.1776	0.1815	0.1752	0.1798	0.035	0.031	0.028	0.039	0.034
AUG 31/88	20	0.1776	0.1819	0.1753	0.1798	0.035	0.035	0.029	0.039	0.035
SEP 28/88	24	0.1774	0.1815	0.1751	0.1795	0.033	0.031	0.027	0.036	0.032
OCT 26/88	28	0.1776	0.1817	0.1753	0.1798	0.035	0.033	0.029	0.039	0.034
NOV 23/88	32	0.1774	0.1815	0.1751	0.1797	0.033	0.031	0.027	0.038	0.032
DEC 21/88	36	0.1777	0.1816	0.1753	0.1798	0.036	0.032	0.029	0.039	0.034
JAN 18/89	40	0.1786	0.1829	0.1765	0.1812	0.046	0.046	0.042	0.054	0.047
FEB 15/89	44	0.1777	0.1819	0.1755	0.1799	0.036	0.035	0.031	0.041	0.036
MAR 15/89	48	0.1779	0.1820	0.1758	0.1803	0.038	0.036	0.034	0.045	0.038
APR 12/89	52	0.1784	0.1826	0.1763	0.1805	0.044	0.043	0.039	0.047	0.043

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 86-6090



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6090 LOCATION: BUTTS POND, NFLD. DATE CAST: MAY 16, 1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 780g SLUMP: 80mm

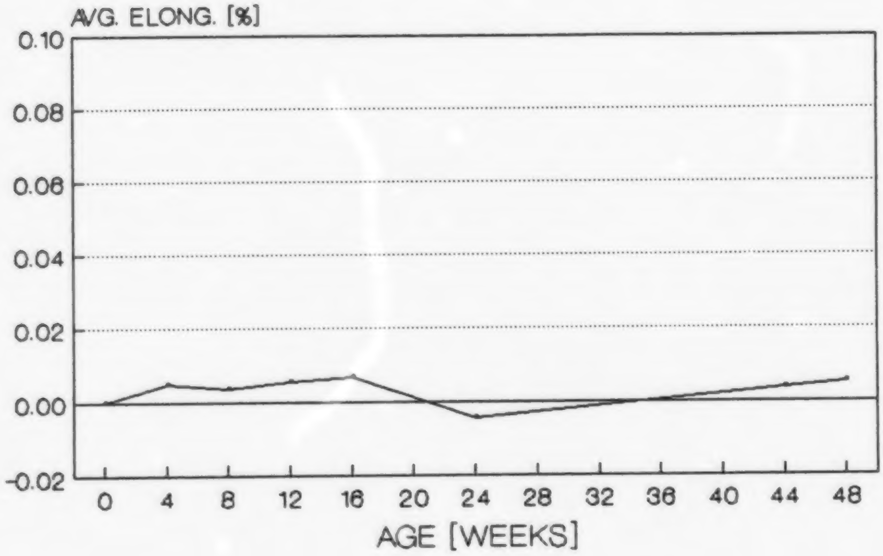
COARSE AGGREGATE: 7180g FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.7447	0.7036	0.7444	0.000	0.000	0.000	0.000
MAR 24/88	1	0.7447	0.7029	0.7453	0.000	-0.006	0.008	0.001
MAR 31/88	2	0.7447	0.7025	0.7453	0.000	-0.010	0.008	-0.001
JUN 14/88	4	0.7451	0.7034	0.7458	0.004	-0.002	0.012	0.005
JUL 12/88	8	0.7453	0.7030	0.7456	0.005	-0.005	0.011	0.004
AUG 09/88	12	0.7454	0.7035	0.7457	0.006	-0.001	0.011	0.006
SEP 06/88	16	0.7453	0.7039	0.7458	0.005	0.003	0.012	0.007
NOV 01/88	24	0.7443	0.7028	0.7441	-0.004	-0.007	-0.003	-0.004
MAR 21/89	44	0.7458	0.7027	0.7454	0.010	-0.008	0.009	0.004
APR 18/89	48	0.7456	0.7029	0.7460	0.008	-0.006	0.014	0.005

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6090



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6091 LOCATION: EASTPORT, NFLD. DATE CAST: MAY 17, 1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 960g SLUMP: 70mm

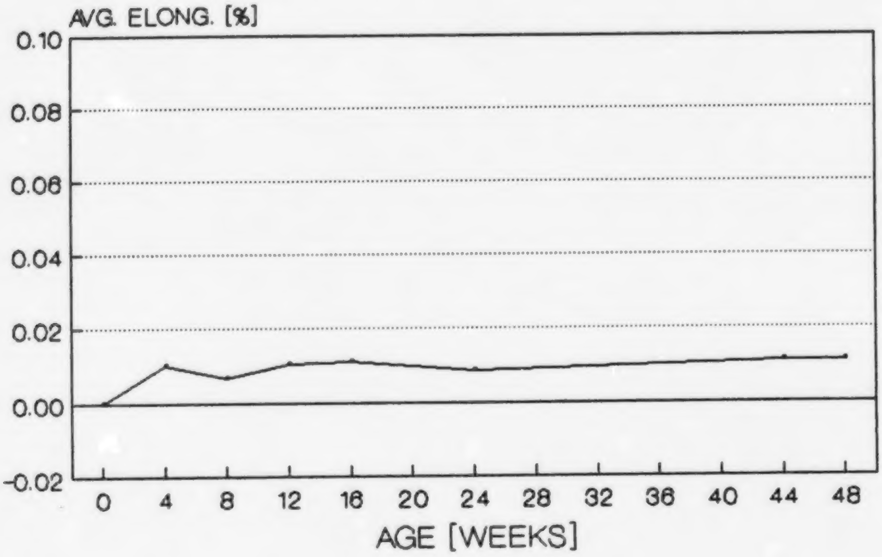
COARSE AGGREGATE: 7180g FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6703	0.6476	0.7375	0.000	0.000	0.000	0.000
MAY 25/88	1	0.6716	0.6487	0.7382	0.012	0.010	0.006	0.009
JUN 01/88	2	0.6715	0.6483	0.7381	0.011	0.006	0.005	0.007
JUN 15/88	4	0.6719	0.6486	0.7383	0.014	0.009	0.007	0.010
JUL 13/88	8	0.6718	0.6482	0.7377	0.013	0.005	0.002	0.007
AUG 10/88	12	0.6716	0.6489	0.7384	0.012	0.012	0.008	0.010
SEP 07/88	16	0.6716	0.6492	0.7383	0.012	0.014	0.007	0.011
NOV 02/88	24	0.6722	0.6488	0.7373	0.017	0.011	-0.002	0.009
MAR 22/89	44	0.6716	0.6491	0.7384	0.012	0.013	0.008	0.011
APR 19/89	48	0.6721	0.6488	0.7382	0.016	0.011	0.006	0.011

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6091



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 86-6093 LOCATION: GOOSE BAY, NFLD. DATE CAST: MAY 4,1988

MIX PROPORTIONS

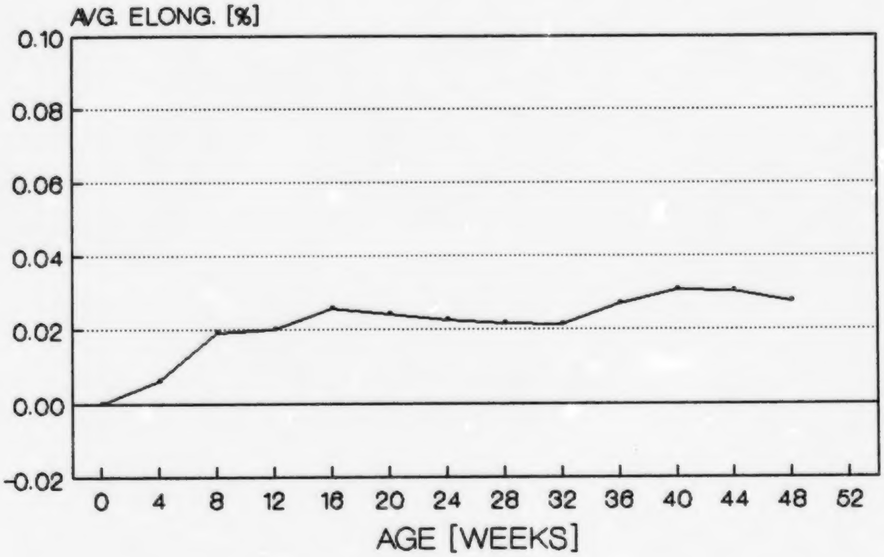
CEMENT: 300g WATER: 120g FINE AGGREGATE: 675g FLOW: 113mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1704	0.1735	0.1707	0.1699	0.000	0.000	0.000	0.000	0.000
MAY 19/88	2	0.1701	0.1742	0.1706	0.1698	-0.003	0.007	-0.001	-0.001	0.001
JUN 02/88	4	0.1706	0.1748	0.1712	0.1703	0.002	0.014	0.005	0.004	0.006
JUN 30/88	8	0.1719	0.1759	0.1724	0.1717	0.016	0.025	0.018	0.019	0.019
JUL 28/88	12	0.1719	0.1760	0.1725	0.1718	0.016	0.026	0.019	0.020	0.020
AUG 25/88	16	0.1725	0.1765	0.1731	0.1723	0.022	0.031	0.025	0.025	0.026
SEP 22/88	20	0.1724	0.1764	0.1729	0.1721	0.021	0.030	0.023	0.023	0.024
OCT 20/88	24	0.1721	0.1761	0.1727	0.1723	0.018	0.027	0.021	0.025	0.023
NOV 17/88	28	0.1721	0.1761	0.1725	0.1722	0.018	0.027	0.019	0.024	0.022
DEC 15/88	32	0.1720	0.1761	0.1725	0.1721	0.017	0.027	0.019	0.023	0.021
JAN 12/89	36	0.1726	0.1767	0.1731	0.1725	0.023	0.033	0.025	0.027	0.027
FEB 09/89	40	0.1731	0.1771	0.1735	0.1726	0.028	0.037	0.029	0.028	0.031
FEB 09/89	44	0.1730	0.1771	0.1734	0.1727	0.027	0.037	0.028	0.029	0.030
APR 06/89	48	0.1727	0.1767	0.1732	0.1725	0.024	0.033	0.026	0.027	0.028
MAY 04/89	52									

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 86-6093



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 86-6094 LOCATION: MARYSTOWN, NFLD. DATE CAST: APRIL 19,1988

MIX PROPORTIONS

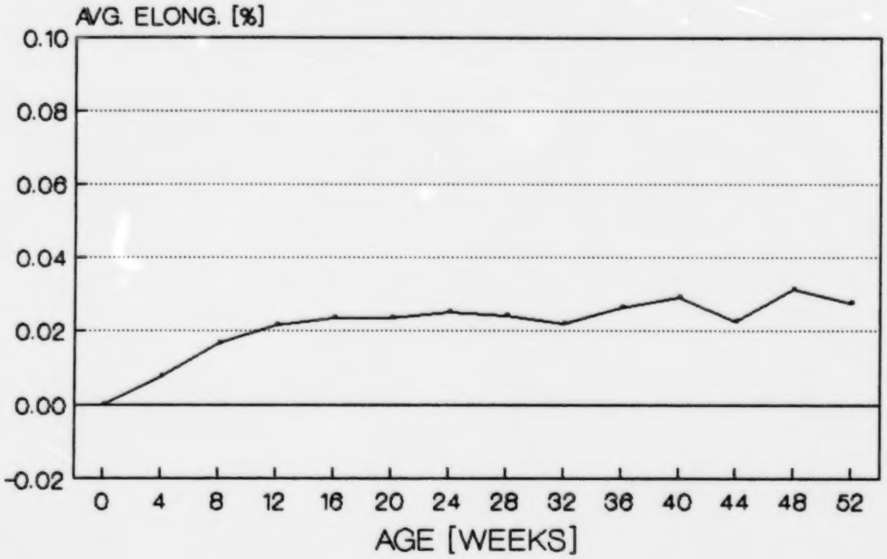
CEMENT: 300g WATER: 125g FINE AGGREGATE: 675g FLOW: 109.2mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1818	0.1827	0.1891	0.1810	0.000	0.000	0.000	0.000	0.000
MAY 04/88	2	0.1820	0.1832	0.1888	0.1813	0.002	0.005	-0.003	0.003	0.002
MAY 18/88	4	0.1825	0.1837	0.1895	0.1819	0.007	0.010	0.004	0.009	0.008
JUN 15/88	8	0.1834	0.1846	0.1903	0.1827	0.017	0.020	0.012	0.018	0.017
JUL 13/88	12	0.1838	0.1851	0.1909	0.1831	0.021	0.025	0.019	0.022	0.022
AUG 10/88	16	0.1840	0.1853	0.1910	0.1834	0.023	0.027	0.020	0.025	0.024
SEP 07/88	20	0.1840	0.1853	0.1910	0.1834	0.023	0.027	0.020	0.025	0.024
OCT 05/88	24	0.1841	0.1857	0.1910	0.1835	0.024	0.031	0.020	0.026	0.025
NOV 02/88	28	0.1841	0.1855	0.1910	0.1833	0.024	0.029	0.020	0.024	0.024
NOV 30/88	32	0.1842	0.1852	0.1905	0.1832	0.025	0.026	0.015	0.023	0.022
DEC 28/88	36	0.1848	0.1854	0.1910	0.1835	0.031	0.028	0.020	0.026	0.026
JAN 25/89	40	0.1853	0.1855	0.1916	0.1834	0.036	0.029	0.026	0.025	0.029
FEB 22/89	44	0.1839	0.1854	0.1907	0.1833	0.022	0.028	0.017	0.024	0.023
MAR 22/89	48	0.1851	0.1863	0.1915	0.1838	0.034	0.037	0.025	0.029	0.031
APR 19/89	52	0.1844	0.1858	0.1913	0.1837	0.027	0.032	0.023	0.028	0.028

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 86-6094



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6094   LOCATION: MARYSTOWN, NFLD.   DATE CAST: MAY 27, 1988

MIX PROPORTIONS

CEMENT: 2170g   WATER: 789g   SLUMP: 85mm

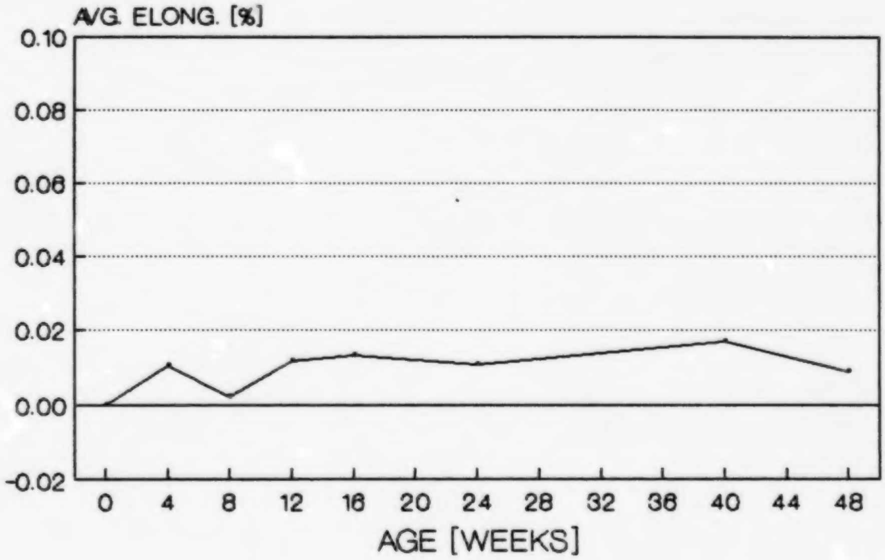
COARSE AGGREGATE: 7180g   FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.7460	0.6516	0.6771	0.000	0.000	0.000	0.000
JUN 04/88	1	0.7462	0.6527	0.6780	0.002	0.010	0.008	0.007
JUN 11/88	2	0.7460	0.6532	0.6782	0.000	0.014	0.010	0.008
JUN 25/88	4	0.7464	0.6538	0.6780	0.004	0.020	0.008	0.010
JUL 23/88	8	0.7457	0.6529	0.6768	-0.003	0.012	-0.003	0.002
AUG 20/88	12	0.7468	0.6536	0.6783	0.007	0.018	0.011	0.012
SEP 17/88	16	0.7469	0.6532	0.6791	0.008	0.014	0.018	0.013
NOV 12/88	24	0.7473	0.6530	0.6781	0.011	0.012	0.009	0.011
MAR 04/89	40	0.7469	0.6536	0.6800	0.008	0.018	0.026	0.017
APR 29/89	48	0.7459	0.6532	0.6786	-0.001	0.014	0.013	0.009

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6094



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 86-6095   LOCATION: CLARENVILLE, NFLD.   DATE CAST: APRIL 15,1988

MIX PROPORTIONS

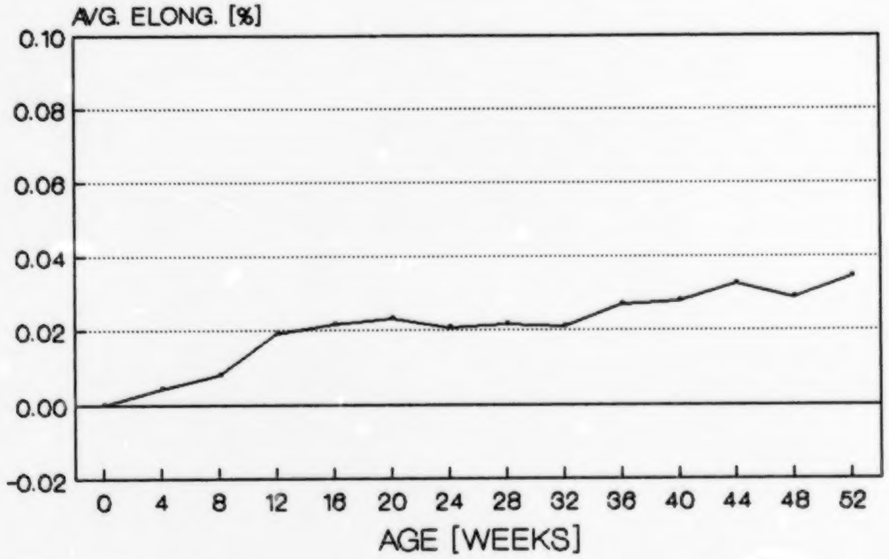
CEMENT: 300g   WATER: 125g   FINE AGGREGATE: 675g   FLOW: 107.2mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1812	0.1810	0.1980	0.1863	0.000	0.000	0.000	0.000	0.000
APR 30/88	2	0.1813	0.1812	0.1978	0.1865	0.001	0.002	-0.002	0.002	0.001
MAY 14/88	4	0.1817	0.1817	0.1982	0.1865	0.005	0.007	0.002	0.002	0.004
JUN 11/88	8	0.1821	0.1822	0.1986	0.1867	0.009	0.012	0.006	0.004	0.008
JUL 09/88	12	0.1833	0.1834	0.1998	0.1874	0.022	0.025	0.019	0.011	0.019
AUG 06/88	16	0.1834	0.1834	0.1999	0.1882	0.023	0.025	0.020	0.020	0.022
SEP 03/88	20	0.1836	0.1836	0.1999	0.1883	0.025	0.027	0.020	0.021	0.023
OCT 01/88	24	0.1835	0.1832	0.1997	0.1881	0.024	0.023	0.018	0.019	0.021
OCT 29/88	28	0.1832	0.1833	0.2000	0.1883	0.021	0.024	0.021	0.021	0.022
NOV 26/88	32	0.1833	0.1833	0.2000	0.1880	0.022	0.024	0.021	0.018	0.021
DEC 24/88	36	0.1838	0.1841	0.2004	0.1886	0.027	0.032	0.025	0.024	0.027
JAN 21/89	40	0.1836	0.1843	0.2001	0.1892	0.025	0.034	0.022	0.030	0.028
FEB 18/89	44	0.1844	0.1845	0.2008	0.1893	0.033	0.036	0.029	0.031	0.033
MAR 18/89	48	0.1842	0.1843	0.2004	0.1887	0.031	0.034	0.025	0.025	0.029
APR 15/89	52	0.1846	0.1847	0.2013	0.1892	0.035	0.038	0.034	0.030	0.035

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 86-6095



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6095 LOCATION: CLARENVILLE, NFLD. DATE CAST: MAY 5, 1988

MIX PROPORTIONS

CEMENT: 2210g WATER: 980g SLUMP: 80mm

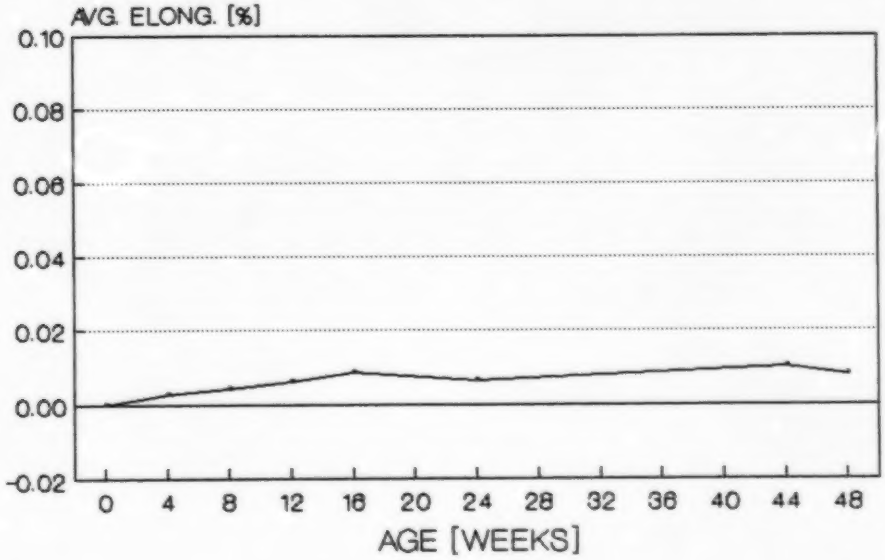
COARSE AGGREGATE: 7180g FINE AGGREGATE: 6730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6224	0.7643	0.7189	0.000	0.000	0.000	0.000
MAY 13/88	1	0.6229	0.7652	0.7190	0.004	0.008	0.001	0.004
MAY 20/88	2	0.6225	0.7649	0.7191	0.001	0.005	0.002	0.003
JUN 03/88	4	0.6225	0.7648	0.7192	0.001	0.004	0.003	0.003
JUL 01/88	8	0.6226	0.7653	0.7191	0.002	0.009	0.002	0.004
JUL 29/88	12	0.6230	0.7657	0.7190	0.005	0.012	0.001	0.006
AUG 26/88	16	0.6230	0.7662	0.7193	0.005	0.017	0.004	0.009
OCT 21/88	24	0.6225	0.7659	0.7194	0.001	0.014	0.004	0.006
MAR 10/89	44	0.6228	0.7663	0.7199	0.004	0.018	0.009	0.010
APR 07/89	48	0.6226	0.7668	0.7189	0.002	0.022	0.000	0.008

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6095



361.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 86-6096 LOCATION: WABUSH, NFLD. DATE CAST: APRIL 6,1988

MIX PROPORTIONS

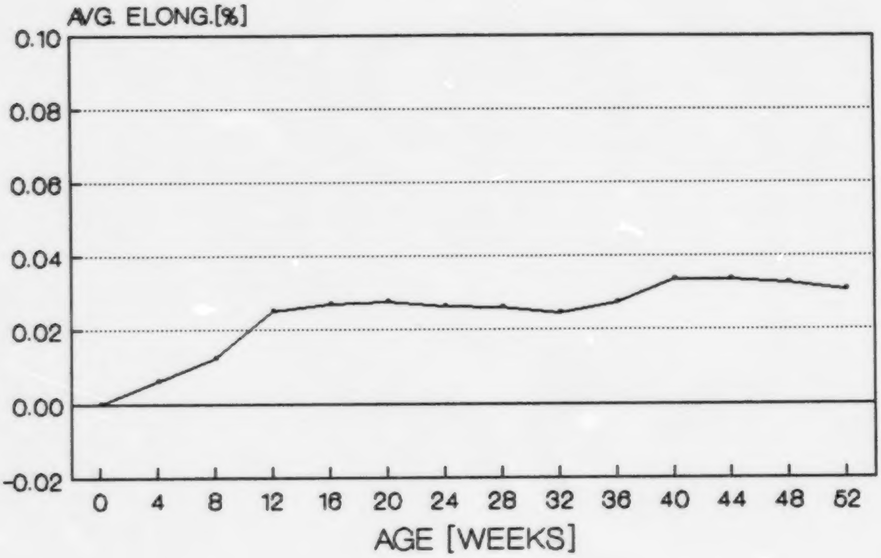
CEMENT: 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 111.7mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1770	0.1732	0.1729	0.1720	0.000	0.000	0.000	0.000	0.000
MAY 05/88	4	0.1781	0.1730	0.1738	0.1725	0.011	-0.002	0.009	0.005	0.006
JUN 02/88	8	0.1788	0.1736	0.1744	0.1731	0.019	0.004	0.016	0.011	0.012
JUN 30/88	12	0.1800	0.1749	0.1756	0.1743	0.031	0.018	0.028	0.024	0.025
JUL 28/88	16	0.1802	0.1751	0.1758	0.1744	0.033	0.020	0.030	0.025	0.027
AUG 25/88	20	0.1803	0.1751	0.1759	0.1745	0.034	0.020	0.031	0.026	0.028
SEP 22/88	24	0.1801	0.1751	0.1758	0.1742	0.032	0.020	0.030	0.023	0.026
OCT 20/88	28	0.1802	0.1751	0.1757	0.1741	0.033	0.020	0.029	0.022	0.026
NOV 17/88	32	0.1801	0.1750	0.1755	0.1740	0.032	0.019	0.027	0.021	0.025
DEC 15/88	36	0.1803	0.1750	0.1755	0.1748	0.034	0.019	0.027	0.029	0.027
JAN 12/89	40	0.1811	0.1758	0.1763	0.1748	0.043	0.027	0.035	0.029	0.034
FEB 09/89	44	0.1812	0.1758	0.1763	0.1747	0.044	0.027	0.035	0.028	0.034
MAR 09/89	48	0.1810	0.1757	0.1762	0.1748	0.042	0.026	0.034	0.029	0.033
APR 06/89	52	0.1808	0.1756	0.1760	0.1746	0.039	0.025	0.032	0.027	0.031

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 86-6096



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 86-6096 LOCATION: WABUSH, NFLD. DATE CAST: MAY 25, 1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 927g SLUMP: 70mm

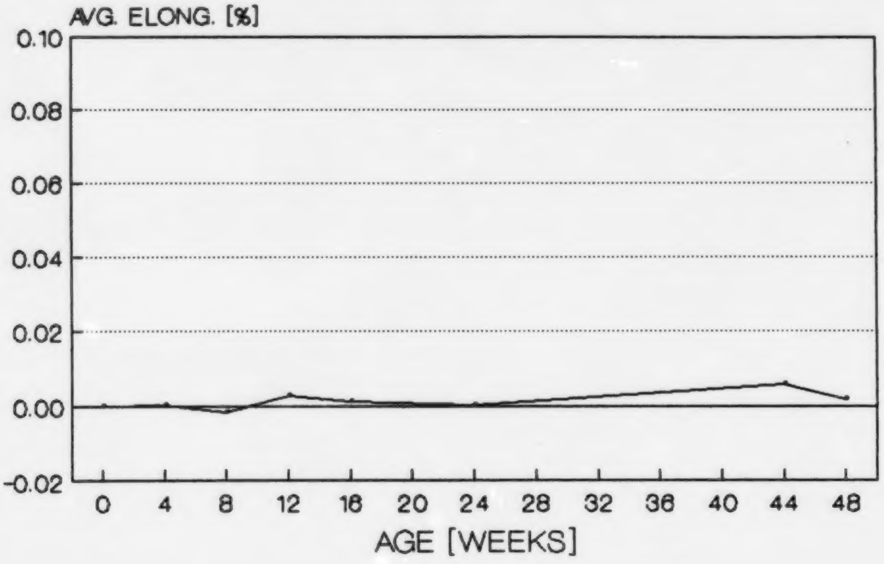
COARSE AGGREGATE: 7180g FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE (WEEKS)	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6694	0.7056	0.6356	0.000	0.000	0.000	0.000
JUN 02/88	1	0.6692	0.7057	0.6359	-0.002	0.001	0.003	0.001
JUN 09/88	2	0.6692	0.7060	0.6332	-0.002	0.004	-0.021	-0.007
JUN 23/88	4	0.6694	0.7058	0.6355	0.000	0.002	-0.001	0.000
JUL 21/88	8	0.6694	0.7049	0.6357	0.000	-0.006	0.001	-0.002
AUG 18/88	12	0.6697	0.7060	0.6358	0.003	0.004	0.002	0.003
SEP 15/88	16	0.6694	0.7057	0.6359	0.000	0.001	0.003	0.001
NOV 10/88	24	0.6690	0.7062	0.6355	-0.004	0.005	-0.001	0.000
MAR 02/89	44	0.6693	0.7070	0.6363	-0.001	0.012	0.006	0.006
APR 27/89	48	0.6691	0.7060	0.6361	-0.003	0.004	0.004	0.002

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 86-6096



361.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 88-GA-01 LOCATION: SEAL COVE, NFLD. DATE CAST: JUNE 10,1988

MIX PROPORTIONS

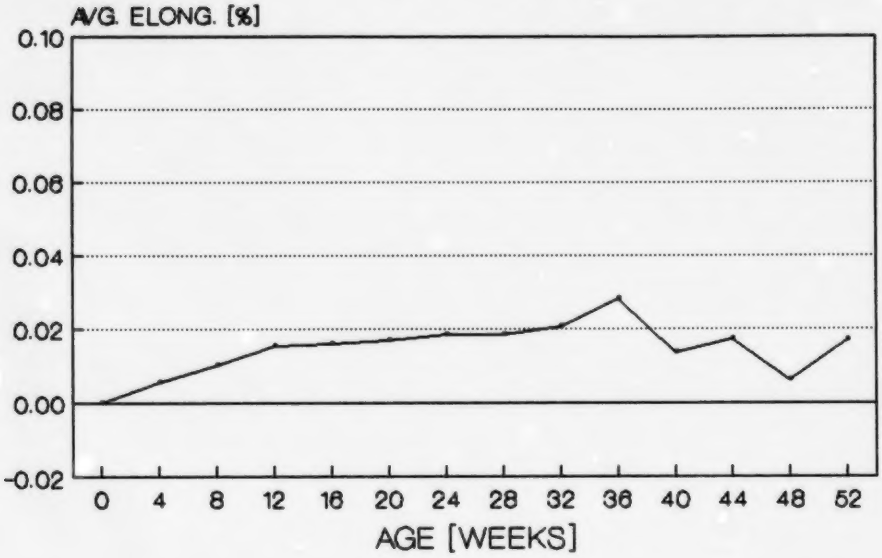
CEMENT: 300g WATER: 115g FINE AGGREGATE: 675g FLOW: 119.7mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1645	0.1723	0.1729	0.1865	0.000	0.000	0.000	0.000	0.000
JUN 25/88	2	0.1652	0.1721	0.1728	0.1867	0.007	-0.002	-0.001	0.002	0.002
JUL 09/88	4	0.1656	0.1724	0.1732	0.1871	0.011	0.001	0.003	0.006	0.005
AUG 06/88	8	0.1660	0.1730	0.1736	0.1875	0.016	0.007	0.007	0.010	0.010
SEP 03/88	12	0.1666	0.1735	0.1741	0.1880	0.022	0.012	0.012	0.016	0.016
OCT 01/88	16	0.1666	0.1735	0.1741	0.1882	0.022	0.012	0.012	0.018	0.016
OCT 29/88	20	0.1668	0.1735	0.1742	0.1883	0.024	0.012	0.014	0.019	0.017
NOV 26/88	24	0.1668	0.1737	0.1744	0.1885	0.024	0.015	0.016	0.021	0.019
DEC 24/88	28	0.1668	0.1737	0.1743	0.1885	0.024	0.015	0.015	0.021	0.018
JAN 21/89	32	0.1671	0.1741	0.1744	0.1886	0.027	0.019	0.016	0.022	0.021
FEB 18/89	36	0.1676	0.1750	0.1749	0.1896	0.032	0.028	0.021	0.032	0.028
MAR 18/89	40	0.1663	0.1732	0.1740	0.1879	0.019	0.009	0.011	0.015	0.014
APR 15/89	44	0.1667	0.1733	0.1743	0.1886	0.023	0.010	0.015	0.022	0.017
MAY 13/89	48	0.1653	0.1729	0.1739	0.1863	0.008	0.006	0.010	-0.002	0.006
JUN 10/89	52	0.1667	0.1733	0.1743	0.1886	0.023	0.010	0.015	0.022	0.017

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 88-GA-01



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 88-GA-01 LOCATION: SEAL COVE, NFLD. DATE CAST: MAY 27, 1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 991g SLUMP: 70mm

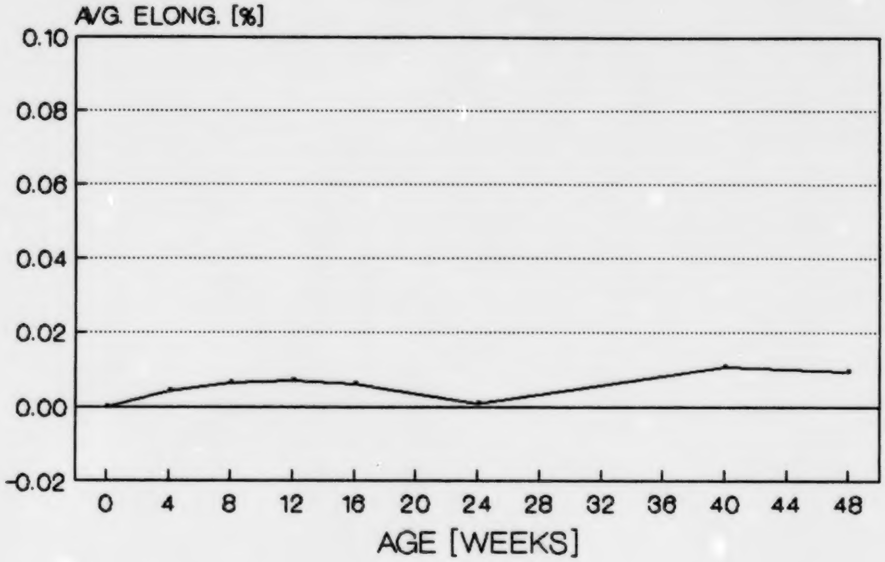
COARSE AGGREGATE: 7180g FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6126	0.6956	0.6457	0.000	0.000	0.000	0.000
JUN 04/88	1	0.6134	0.6954	0.6447	0.007	-0.002	-0.009	-0.001
JUN 11/88	2	0.6137	0.6952	0.6461	0.010	-0.004	0.004	0.003
JUN 25/88	4	0.6134	0.6959	0.6460	0.007	0.003	0.003	0.004
JUL 23/88	8	0.6136	0.6964	0.6461	0.009	0.007	0.004	0.007
AUG 20/88	12	0.6137	0.6963	0.6463	0.010	0.006	0.005	0.007
SEP 17/88	16	0.6135	0.6962	0.6463	0.008	0.005	0.005	0.006
NOV 12/88	24	0.6131	0.6951	0.6460	0.004	-0.004	0.003	0.001
MAR 04/89	40	0.6137	0.6962	0.6476	0.010	0.005	0.017	0.011
APR 29/89	48	0.6130	0.6971	0.6470	0.004	0.013	0.012	0.009

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 88-GA-01



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 88-GA-02 LOCATION: ST. JOHN'S, NFLD. DATE CAST: JUNE 10,1988

MIX PROPORTIONS

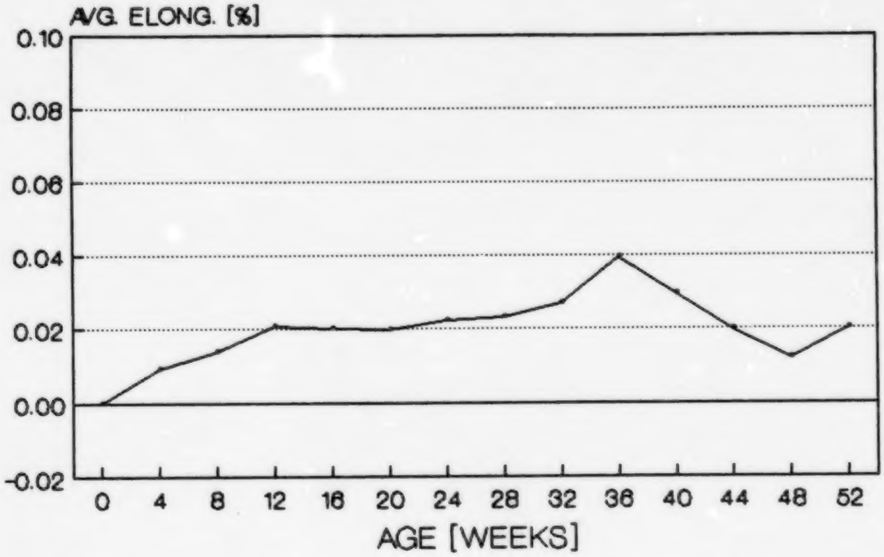
CEMENT: 300g WATER: 115g FINE AGGREGATE: 675g FLOW: 110.1mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1694	0.1689	0.1677	0.1718	0.000	0.000	0.000	0.000	0.000
JUN 25/88	2	0.1699	0.1694	0.1680	0.1722	0.005	0.005	0.003	0.004	0.004
JUL 09/88	4	0.1703	0.1699	0.1685	0.1727	0.009	0.010	0.008	0.009	0.009
AUG 06/88	8	0.1707	0.1703	0.1689	0.1732	0.013	0.015	0.012	0.015	0.014
SEP 03/88	12	0.1715	0.1710	0.1695	0.1738	0.022	0.022	0.019	0.021	0.021
OCT 01/88	16	0.1714	0.1710	0.1693	0.1739	0.021	0.022	0.017	0.022	0.020
OCT 29/88	20	0.1714	0.1710	0.1695	0.1736	0.021	0.022	0.019	0.019	0.020
NOV 26/88	24	0.1719	0.1711	0.1698	0.1736	0.026	0.023	0.022	0.019	0.022
DEC 24/88	28	0.1720	0.1711	0.1698	0.1739	0.027	0.023	0.022	0.022	0.023
JAN 21/89	32	0.1725	0.1717	0.1698	0.1742	0.032	0.029	0.022	0.025	0.027
FEB 18/89	36	0.1733	0.1722	0.1722	0.1753	0.041	0.034	0.047	0.036	0.039
MAR 18/89	40	0.1725	0.1715	0.1712	0.1740	0.032	0.027	0.036	0.023	0.030
APR 15/89	44	0.1716	0.1706	0.1696	0.1737	0.023	0.018	0.020	0.020	0.020
MAY 13/89	48	0.1705	0.1692	0.1699	0.1730	0.011	0.003	0.023	0.012	0.012
JUN 10/89	52	0.1716	0.1706	0.1696	0.1737	0.023	0.018	0.020	0.020	0.020

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 88-GA-02



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 88-GA-02 LOCATION: ST. JOHN'S, NFLD. DATE CAST: MAY 31,1988

MIX PROPORTIONS

CEMENT: 2210g WATER: 1026g SLUMP: 70mm

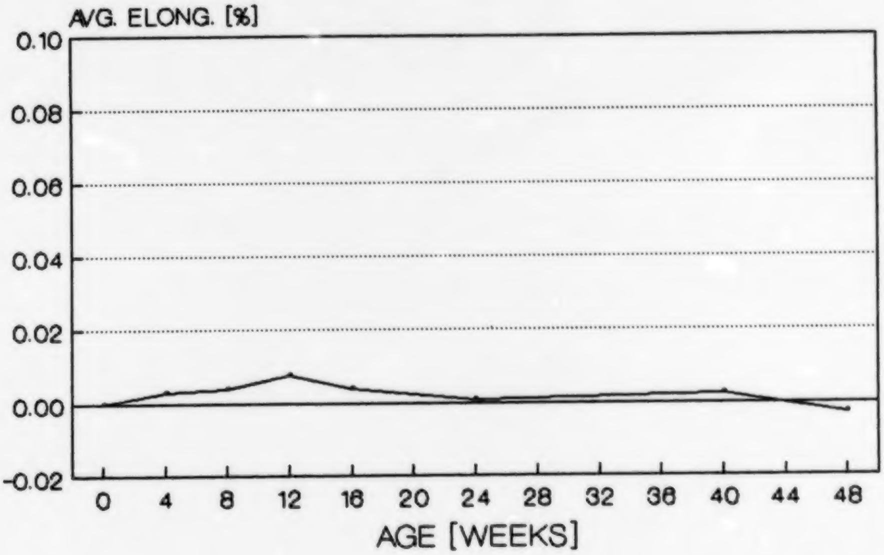
COARSE AGGREGATE: 7180g FINE AGGREGATE: 6730g

LENGTH MEASUREMENTS

DATE	AGE (WEEKS)	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6883	0.6446	0.7552	0.000	0.000	0.000	0.000
JUN 15/88	2	0.6879	0.6447	0.7557	-0.004	0.001	0.004	0.001
JUN 29/88	4	0.6883	0.6450	0.7558	0.000	0.004	0.005	0.003
JUL 27/88	8	0.6888	0.6447	0.7559	0.004	0.001	0.006	0.004
AUG 24/88	12	0.6892	0.6453	0.7562	0.008	0.006	0.009	0.008
SEP 21/88	16	0.6889	0.6450	0.7555	0.005	0.004	0.003	0.004
NOV 16/88	24	0.6883	0.6446	0.7555	0.000	0.000	0.003	0.001
MAR 08/89	40	0.6885	0.6443	0.7561	0.002	-0.003	0.008	0.002
MAY 03/89	48	0.6878	0.6435	0.7558	-0.004	-0.010	0.005	-0.003

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 88-GA-02



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: 88-GA-03 LOCATION: MACKINSONS, NFLD. DATE CAST: JUNE 7,1988

MIX PROPORTIONS

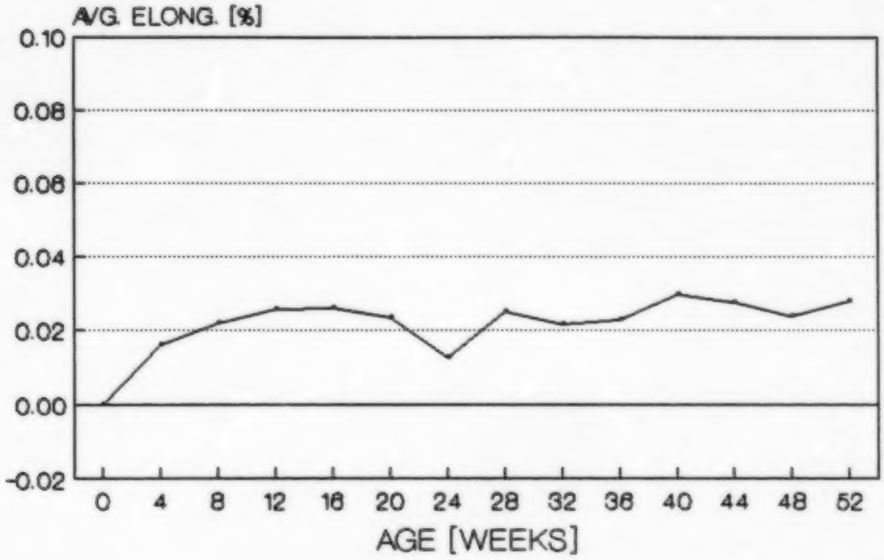
CEMENT: 300g WATER: 115g FINE AGGREGATE: 675g FLOW 119.7mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1740	0.1725	0.1718	0.1663	0.000	0.000	0.000	0.000	0.000
JUN 22/88	2	0.1747	0.1730	0.1724	0.1669	0.007	0.005	0.006	0.006	0.006
JUL 06/88	4	0.1757	0.1740	0.1733	0.1678	0.018	0.016	0.016	0.016	0.016
AUG 03/88	8	0.1762	0.1747	0.1738	0.1684	0.023	0.023	0.021	0.022	0.022
AUG 31/88	12	0.1766	0.1750	0.1741	0.1688	0.027	0.026	0.024	0.026	0.026
SEP 28/88	16	0.1767	0.1751	0.1742	0.1687	0.028	0.027	0.025	0.025	0.026
OCT 26/88	20	0.1763	0.1749	0.1740	0.1685	0.024	0.025	0.023	0.023	0.024
NOV 23/88	24	0.1750	0.1736	0.1734	0.1675	0.010	0.011	0.017	0.012	0.013
DEC 21/88	28	0.1764	0.1749	0.1744	0.1686	0.025	0.025	0.027	0.024	0.025
JAN 18/89	32	0.1764	0.1743	0.1741	0.1682	0.025	0.019	0.024	0.020	0.022
FEB 15/89	36	0.1765	0.1746	0.1740	0.1684	0.026	0.022	0.023	0.022	0.023
MAR 15/89	40	0.1770	0.1753	0.1745	0.1693	0.031	0.029	0.028	0.031	0.030
APR 12/89	44	0.1771	0.1751	0.1744	0.1687	0.032	0.027	0.027	0.025	0.028
MAY 10/89	48	0.1765	0.1748	0.1742	0.1684	0.026	0.024	0.025	0.022	0.024
JUN 07/89	52	0.1771	0.1751	0.1744	0.1687	0.032	0.027	0.027	0.025	0.028

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: 88-GA-03



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 88-GA-03 LOCATION: MACKISONS, NFLD. DATE CAST: MAY 31, 1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 920g SLUMP: 90mm

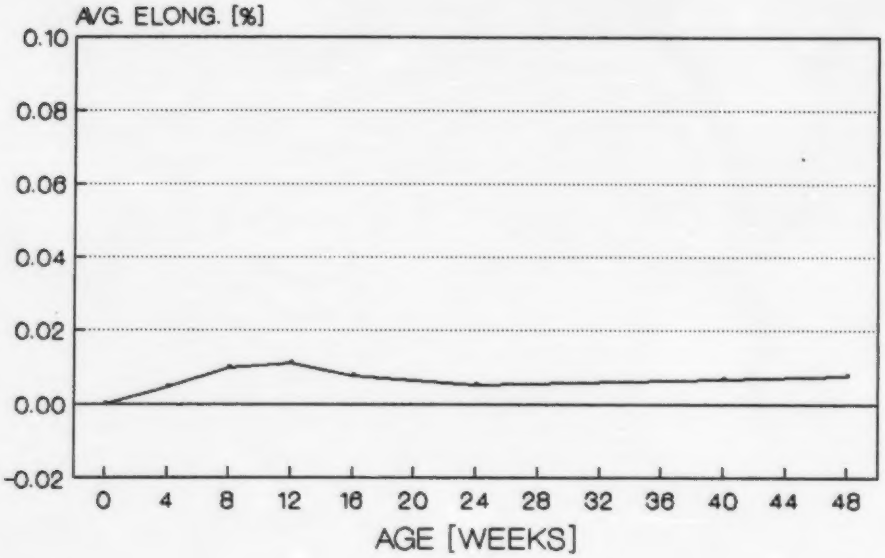
COARSE AGGREGATE: 7180g FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6553	0.7105	0.6727	0.000	0.000	0.000	0.000
JUN 08/88	1	0.6554	0.7106	0.6728	0.001	0.001	0.001	0.001
JUN 15/88	2	0.6554	0.7109	0.6728	0.001	0.004	0.001	0.002
JUN 29/88	4	0.6557	0.7112	0.6731	0.004	0.006	0.004	0.004
JUL 27/88	8	0.6564	0.7120	0.6734	0.010	0.013	0.006	0.010
AUG 24/88	12	0.6564	0.7118	0.6741	0.010	0.012	0.012	0.011
SEP 21/88	16	0.6561	0.7112	0.6738	0.007	0.006	0.010	0.008
NOV 16/88	24	0.6556	0.7115	0.6732	0.003	0.009	0.004	0.005
MAR 08/89	40	0.6558	0.7118	0.6732	0.004	0.012	0.004	0.007
MAY 03/89	48	0.6560	0.7111	0.6740	0.006	0.005	0.012	0.008

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 88-GA-03



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 88-GA-04

LOCATION: PIPERS HOLE, NFLD.

DATE CAST: JUNE 3, 1988

MIX PROPORTIONS

CEMENT: 2170g

WATER: 979g

SLUMP: 90mm

COARSE AGGREGATE: 7180g

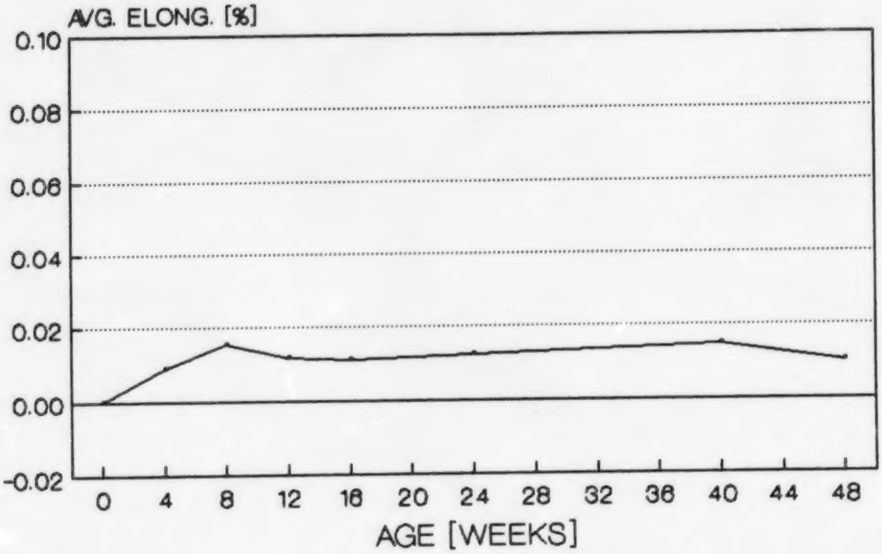
FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6340	0.7195	0.6658	0.000	0.000	0.000	0.000
JUN 11/88	1	0.6341	0.7196	0.6660	0.001	0.001	0.002	0.001
JUN 18/88	2	0.6348	0.7198	0.6663	0.007	0.003	0.004	0.005
JUL 02/88	4	0.6353	0.7205	0.6665	0.012	0.009	0.006	0.009
JUL 30/88	8	0.6355	0.7215	0.6675	0.013	0.018	0.015	0.015
AUG 27/88	12	0.6349	0.7210	0.6674	0.008	0.013	0.014	0.012
SEP 24/88	16	0.6353	0.7207	0.6670	0.012	0.011	0.011	0.011
NOV 19/88	24	0.6355	0.7207	0.6673	0.013	0.011	0.013	0.012
MAR 11/89	40	0.6352	0.7215	0.6676	0.011	0.018	0.016	0.015
MAY 06/89	48	0.6346	0.7212	0.6669	0.005	0.015	0.010	0.010

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 88-GA-04



MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: 88-GA-05 LOCATION: SWIFT CURRENT, NFLD. DATE CAST: JUNE 3, 1988

MIX PROPORTIONS

CEMENT: 2170g WATER: 978g SLUMP: 70mm

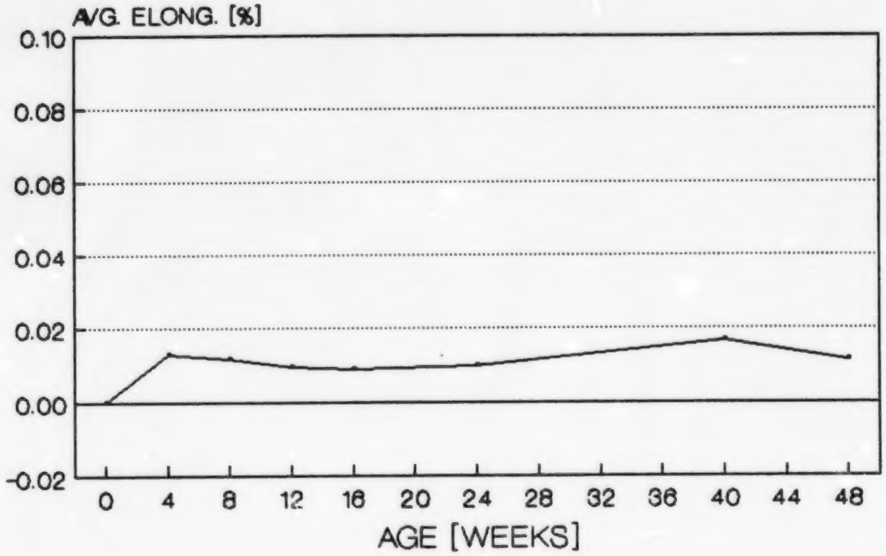
COARSE AGGREGATE: 7180g FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6532	0.6810	0.6801	0.000	0.000	0.000	0.000
JUN 11/88	1	0.6536	0.6816	0.6804	0.004	0.005	0.003	0.004
JUN 18/88	2	0.6538	0.6824	0.6805	0.005	0.012	0.004	0.007
JUL 02/88	4	0.6543	0.6835	0.6809	0.010	0.022	0.007	0.013
JUL 30/88	8	0.6549	0.6823	0.6811	0.015	0.012	0.009	0.012
AUG 27/88	12	0.6547	0.6823	0.6805	0.013	0.012	0.004	0.009
SEP 24/88	16	0.6550	0.6821	0.6802	0.016	0.010	0.001	0.009
NOV 19/88	24	0.6544	0.6825	0.6807	0.011	0.013	0.005	0.010
MAR 11/89	40	0.6546	0.6836	0.6818	0.012	0.023	0.015	0.017
MAY 06/89	48	0.6550	0.6820	0.6812	0.016	0.009	0.010	0.012

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: 88-GA-05



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: INERT SAND NO. 1 - CONTROL LOCATION: GUELPH, ONT. DATE CAST: MARCH 30, 1988

MIX PROPORTIONS

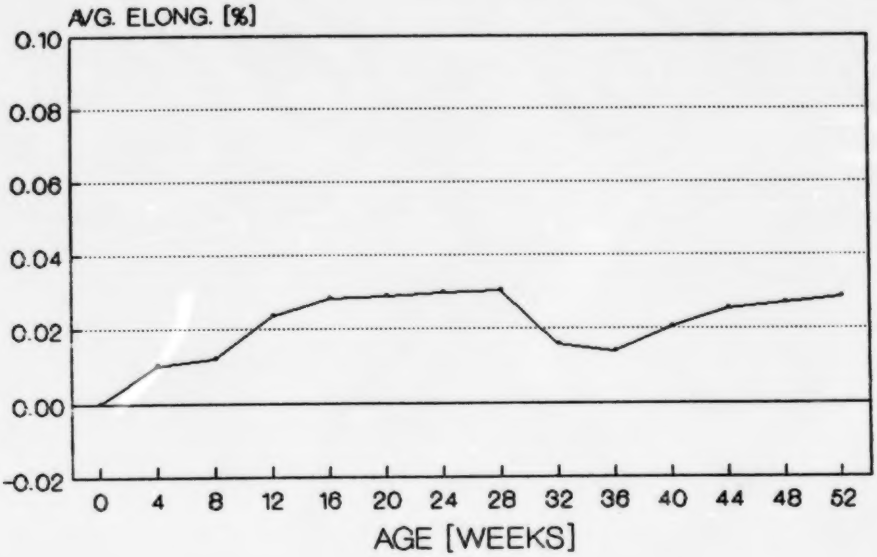
CEMENT: 300g WATER: 110g FINE AGGREGATE: 675g FLOW: 111mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1685	0.1695	0.1707	0.1206	0.000	0.000	0.000	0.000	0.000
APR 14/88	2	0.1684	0.1697	0.1710	0.1203	-0.001	0.002	0.003	-0.003	0.000
APR 28/88	4	0.1695	0.1706	0.1719	0.1212	0.010	0.011	0.012	0.006	0.010
MAY 26/88	8	0.1696	0.1707	0.1722	0.1214	0.011	0.012	0.016	0.008	0.012
JUN 23/88	12	0.1707	0.1719	0.1733	0.1225	0.023	0.025	0.027	0.020	0.024
JUL 21/88	16	0.1711	0.1724	0.1738	0.1229	0.027	0.030	0.032	0.024	0.028
AUG 18/88	20	0.1711	0.1724	0.1738	0.1231	0.027	0.030	0.032	0.026	0.029
SEP 15/88	24	0.1712	0.1723	0.1743	0.1230	0.028	0.029	0.037	0.025	0.030
OCT 13/88	28	0.1714	0.1725	0.1738	0.1234	0.030	0.031	0.032	0.029	0.031
NOV 10/88	32	0.1701	0.1712	0.1724	0.1217	0.017	0.018	0.018	0.011	0.016
DEC 08/88	36	0.1698	0.1709	0.1724	0.1216	0.013	0.015	0.018	0.010	0.014
JAN 05/89	40	0.1705	0.1716	0.1728	0.1223	0.021	0.022	0.022	0.018	0.020
FEB 02/89	44	0.1710	0.1721	0.1732	0.1228	0.026	0.027	0.026	0.023	0.025
MAR 02/89	48	0.1712	0.1722	0.1730	0.1233	0.028	0.028	0.024	0.028	0.027
MAR 30/89	52	0.1713	0.1724	0.1735	0.1231	0.029	0.030	0.029	0.026	0.029

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: INERT SAND NO. 1



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: INERT SAND NO. 2 - CONTROL   LOCATION: GUELPH, ONT.   DATE CAST: MARCH 30, 1988

MIX PROPORTIONS

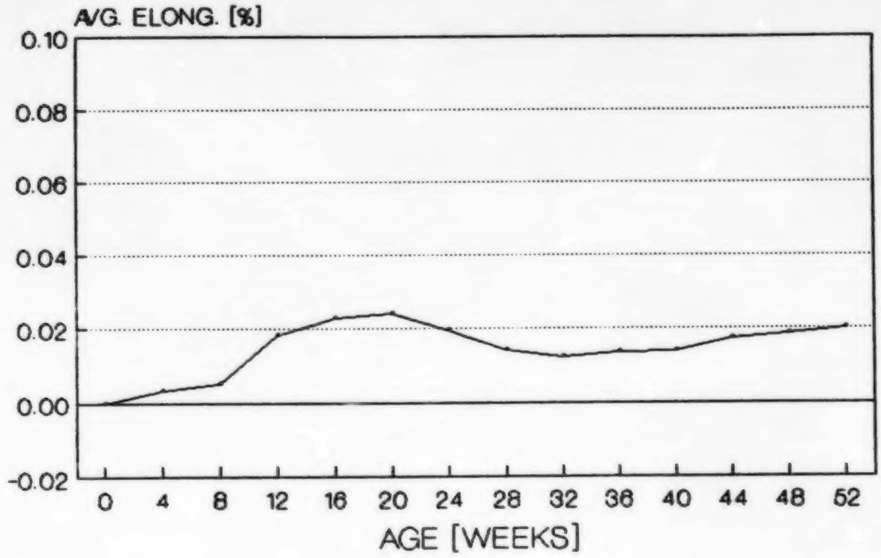
CEMENT: 350g   WATER: 135.8g   FINE AGGREGATE: 787.5g   FLOW: 117mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1851	0.1885	0.1759	0.1720	0.000	0.000	0.000	0.000	0.000
APR 14/88	2	0.1849	0.1881	0.1747	0.1712	-0.002	-0.004	-0.023	-0.008	-0.009
APR 28/88	4	0.1859	0.1892	0.1757	0.1721	0.008	0.007	-0.004	0.001	0.003
MAY 26/88	8	0.1860	0.1894	0.1758	0.1724	0.009	0.009	-0.002	0.004	0.005
JUN 23/88	12	0.1869	0.1903	0.1769	0.1735	0.019	0.019	0.020	0.016	0.018
JUL 21/88	16	0.1874	0.1906	0.1773	0.1738	0.024	0.022	0.027	0.019	0.023
AUG 18/88	20	0.1874	0.1907	0.1774	0.1740	0.024	0.023	0.029	0.021	0.024
SEP 15/88	24	0.1870	0.1902	0.1770	0.1739	0.020	0.018	0.021	0.020	0.020
OCT 13/88	28	0.1867	0.1898	0.1765	0.1734	0.017	0.014	0.012	0.015	0.014
NOV 10/88	32	0.1860	0.1895	0.1767	0.1734	0.009	0.010	0.016	0.015	0.012
DEC 08/88	36	0.1860	0.1896	0.1769	0.1733	0.009	0.011	0.020	0.014	0.013
JAN 05/89	40	0.1866	0.1903	0.1764	0.1731	0.016	0.019	0.010	0.011	0.014
FEB 02/89	44	0.1868	0.1905	0.1767	0.1735	0.018	0.021	0.016	0.016	0.017
MAR 02/89	48	0.1874	0.1910	0.1763	0.1736	0.024	0.026	0.008	0.017	0.019
MAR 30/89	52	0.1872	0.1908	0.1769	0.1735	0.022	0.024	0.020	0.016	0.020

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: INERT SAND NO. 2



361.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: PITTSBURGH - CONTROL   LOCATION: KINGSTON, ONT.   DATE CAST: MAY 10, 1988

MIX PROPORTIONS

CEMENT: 6200g   WATER: 2260g   SLUMP: 90mm

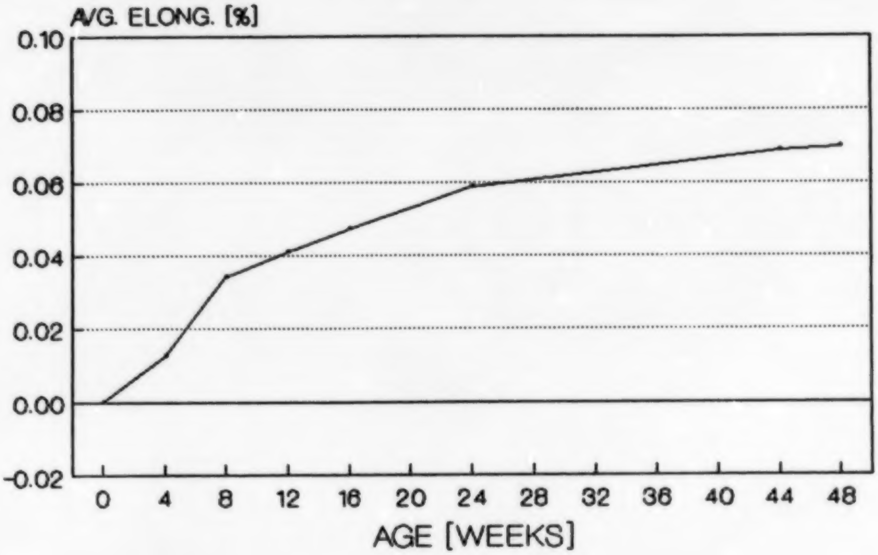
COARSE AGGREGATE: 20 520g   FINE AGGREGATE: 16 380g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.8012	0.7472	0.6397	0.000	0.000	0.000	0.000
MAY 18/88	1	0.8014	0.7477	0.6395	0.002	0.004	-0.002	0.001
MAY 25/88	2	0.8020	0.7482	0.6402	0.007	0.009	0.004	0.007
JUN 08/88	4	0.8030	0.7490	0.6404	0.016	0.016	0.006	0.013
JUL 06/88	8	0.8051	0.7514	0.6432	0.034	0.037	0.031	0.034
AUG 03/88	12	0.8057	0.7523	0.6440	0.040	0.045	0.038	0.041
AUG 31/88	16	0.8064	0.7529	0.6449	0.046	0.050	0.046	0.047
OCT 26/88	24	0.8074	0.7544	0.6463	0.054	0.064	0.059	0.059
MAR 15/89	44	0.8079	0.7565	0.6471	0.059	0.082	0.066	0.069
APR 12/89	48	0.8081	0.7562	0.6475	0.061	0.079	0.069	0.070

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: PITTSBURGH



861.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: SUDBURY - CONTROL   LOCATION: SUDBURY, ONT.   DATE CAST: MAY 12, 1988

MIX PROPORTIONS

CEMENT: 2170g   WATER: 760g   SLUMP: 70mm

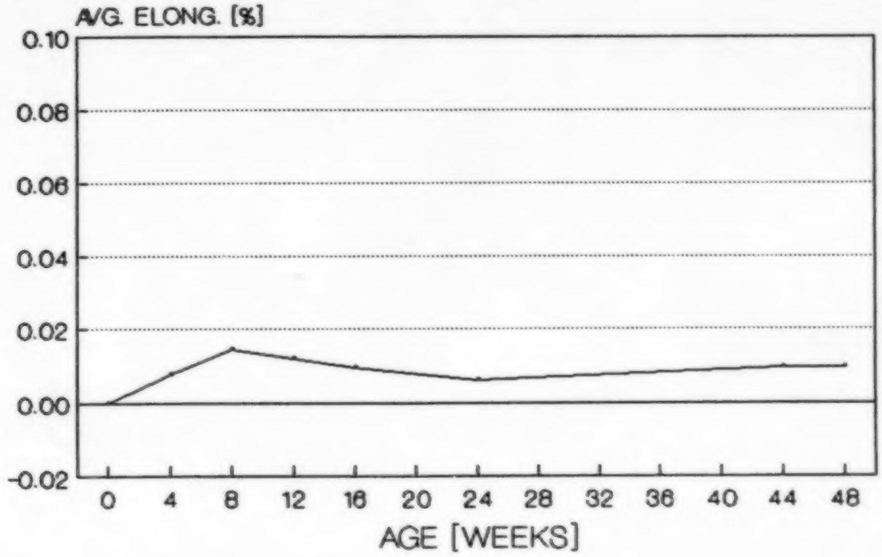
COARSE AGGREGATE: 7180g   FINE AGGREGATE: 5730g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.7764	0.7318	0.7812	0.000	0.000	0.000	0.000
MAY 20/88	1	0.7771	0.7316	0.7811	0.006	-0.002	-0.001	0.001
MAY 27/88	2	0.7778	0.7317	0.7814	0.012	-0.001	0.002	0.004
JUN 10/88	4	0.7778	0.7322	0.7820	0.012	0.004	0.007	0.008
JUL 08/88	8	0.7782	0.7333	0.7828	0.016	0.013	0.014	0.014
AUG 05/88	12	0.7782	0.7329	0.7824	0.016	0.010	0.011	0.012
SEP 02/88	16	0.7780	0.7326	0.7820	0.014	0.007	0.007	0.009
OCT 28/88	24	0.7769	0.7325	0.7821	0.004	0.006	0.008	0.006
MAR 17/89	44	0.7777	0.7327	0.7822	0.011	0.008	0.009	0.009
APR 14/89	48	0.7770	0.7333	0.7824	0.005	0.013	0.011	0.010

CONCRETE PRISM EXPANSION GRSPH

SAMPLE NO.: SUDBURY



861.5024

MIX PROPORTIONS AND MEASUREMENTS - MORTAR BARS

SAMPLE NO.: SPRATT - CONTROL

LOCATION: STITTSVILLE, ONT.

DATE CAST: JUNE 7, 1988

MIX PROPORTIONS

CEMENT: 300g

WATER: 120g

FINE AGGREGATE: 675g

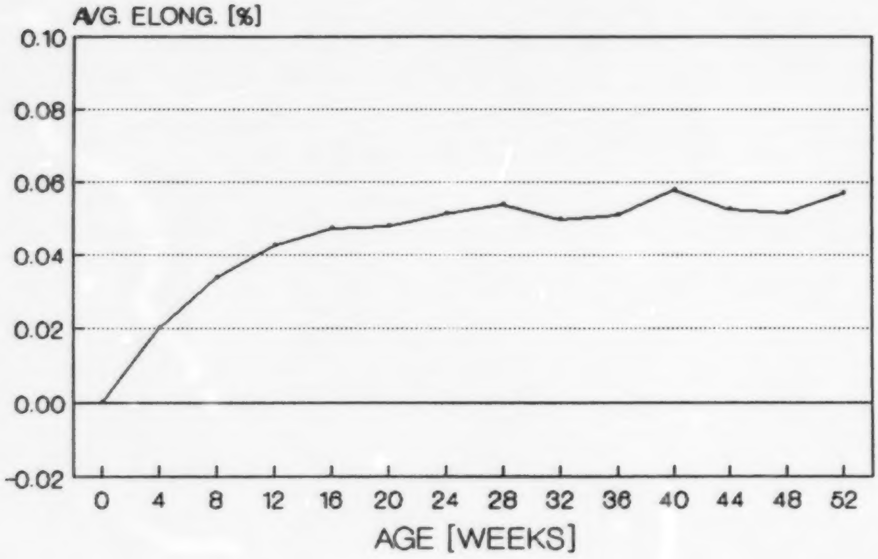
FLOW: 103.4mm

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	READING 4	% ELONG. 1	% ELONG. 2	% ELONG. 3	% ELONG. 4	AVG. % ELONG.
INITIAL	0	0.1702	0.1663	0.1667	0.1662	0.000	0.000	0.000	0.000	0.000
JUN 22/88	2	0.1708	0.1669	0.1674	0.1669	0.006	0.006	0.007	0.007	0.007
JUL 06/88	4	0.1724	0.1680	0.1686	0.1682	0.023	0.018	0.020	0.021	0.020
AUG 03/88	8	0.1737	0.1696	0.1698	0.1693	0.036	0.034	0.032	0.032	0.034
AUG 31/88	12	0.1746	0.1706	0.1705	0.1701	0.046	0.045	0.039	0.040	0.043
SEP 28/88	16	0.1749	0.1711	0.1710	0.1706	0.049	0.050	0.045	0.046	0.047
OCT 26/88	20	0.1750	0.1712	0.1711	0.1706	0.050	0.051	0.046	0.046	0.048
NOV 23/88	24	0.1750	0.1716	0.1716	0.1710	0.050	0.055	0.051	0.050	0.051
DEC 21/88	28	0.1756	0.1717	0.1716	0.1713	0.056	0.056	0.051	0.053	0.054
JAN 18/89	32	0.1753	0.1715	0.1711	0.1707	0.053	0.054	0.046	0.047	0.050
FEB 15/89	36	0.1754	0.1715	0.1713	0.1709	0.054	0.054	0.048	0.049	0.051
MAR 15/89	40	0.1760	0.1721	0.1719	0.1717	0.060	0.060	0.054	0.057	0.058
APR 12/89	44	0.1754	0.1716	0.1717	0.1710	0.054	0.055	0.052	0.050	0.053
MAY 10/89	48	0.1752	0.1716	0.1715	0.1710	0.052	0.055	0.050	0.050	0.052
JUN 07/89	52	0.1758	0.1720	0.1720	0.1715	0.058	0.059	0.055	0.055	0.057

MORTAR BAR EXPANSION GRAPH

SAMPLE NO.: SPRATT



361.5024

MIX PROPORTIONS AND MEASUREMENTS - CONCRETE PRISMS

SAMPLE NO.: SPRATT - CONTROL LOCATION: STITTSVILLE, ONT. DATE CAST: MAY 11, 1988

MIX PROPORTIONS

CEMENT: 6200g WATER: 1920g SLUMP: 85mm

COARSE AGGREGATE: 20 520g FINE AGGREGATE: 16 380g

LENGTH MEASUREMENTS

DATE	AGE [WEEKS]	READING 1	READING 2	READING 3	% ELONG. 1	% ELONG. 2	% ELONG. 3	AVG. % ELONG.
INITIAL	0	0.6613	0.6616	0.7182	0.000	0.000	0.000	0.000
MAY 19/88	1	0.6622	0.6628	0.7200	0.008	0.011	0.016	0.012
MAY 26/88	2	0.6643	0.6640	0.7207	0.027	0.021	0.022	0.023
JUN 09/88	4	0.6616	0.6633	0.7201	0.003	0.015	0.017	0.012
JUL 07/88	8	0.6620	0.6626	0.7208	0.006	0.009	0.023	0.013
AUG 04/88	12	0.6611	0.6620	0.7206	-0.002	0.004	0.021	0.008
SEP 01/88	16	0.6614	0.6627	0.7204	0.001	0.010	0.019	0.010
OCT 27/88	24	0.6615	0.6624	0.7200	0.002	0.007	0.016	0.008
MAR 16/89	40	0.6623	0.6636	0.7212	0.007	0.018	0.027	0.018
APR 13/89	48	0.6620	0.6635	0.7210	0.006	0.017	0.025	0.016

CONCRETE PRISM EXPANSION GRAPH

SAMPLE NO.: SPRATT